PROCESS HAZARD ANALYSIS

40 Railroad Avenue
Merrimack, NH 03054

February 19, 2014

JCI JONES CHEMICALS, INC.
Process Hazard Analysis
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SECTION 1
INTRODUCTION AND SUMMARY

1.0 Purpose

This document is the Process Hazard Analysis for the JCI Jones Chemicals, Inc. (JCI) facility located at 40 Railroad Avenue, Merrimack, New Hampshire.

1.1 Applicability

The Occupational Safety and Health Administration (OSHA) has issued regulations titled *Process Safety Management of Highly Hazardous Chemicals* in the workplace. These regulations are contained in Title 29, Code of Federal Regulations (29 CFR) section 1910.119 and apply to a facility that manages Highly Hazardous Chemicals (HHC's). An HHC is both listed by name by OSHA at 29 CFR 1910.119, Appendix A, and is stored at a facility in quantities at or above an OSHA specified Threshold Quantity (TQ). All JCI operating facilities (as contrasted to locations which are just offices) have one or more HHC's at the facility. The compliance guide for these regulations is contained in the JCI Safety Manual, Chapter 4.

One requirement of the standard, found at 29 CFR 1910.119(e), is that the facility must conduct a Process Hazard Analysis (PHA) for each Highly Hazardous Chemical (HHC). The PHA must determine and evaluate the hazards of the process being evaluated. It must address: hazards of the process: identification of previous incident(s) which had a likely potential for catastrophic consequences in the workplace; engineering and administrative controls and the consequences if they fail; facility siting; human factors; qualitative evaluation of the possible safety and health effects of failure of controls on employees in the workplace.

Each recommendation developed during the PHA must be communicated to the employees and the resolution of each recommendation is documented.

1.2 Methodology

The format and general content of the PHA was developed using industry standards and recommend practices (primarily those of the Chlorine Institute and Compressed Gas Association), corporate standard operating procedures, the “What-If?” methodology as approved by OSHA in 29 CFR 1910.119(e)(2)(i), and local conditions. The “What-If?” methodology is discussed in more detail in Section 11.

1.3 Facility Overview

This facility's primary function is to protect public health by supplying chemicals to disinfect bulk water systems. The primary operations conducted at this facility include the distribution of inorganic chemicals and repackaging of inorganic gases. HHCs are brought on site either in railcars (in the case of chlorine) or 2000 pound containers and 150 pound cylinders (in the case of sulfur dioxide), and then either repackaged into smaller containers (2000 pound containers and 150 pound cylinders) and or used in the facility’s manufacturing processes, both of which are discussed in more detail in Section 3, and then transported to customers on an as-needed-basis. Any residual compressed gas is absorbed in an appropriate solution and sold as product.

The HHC's, respective TQ's, and Maximum Intended Inventory at this facility are listed in the table below.

HHC	TQ	Maximum Intended Inventory
Chlorine	1,500 pounds	975,000 pounds
Sulfur dioxide	1,000 pounds	51,600 pounds

The maximum intended inventory for chlorine is based on 5 x 180,000 pound railcars (the single largest vessel of chlorine on-site), 30 x 2,000 pound containers, and 100 x 150 pound cylinders. The maximum intended inventory for sulfur dioxide is based on 24 x 2,000 pound containers (the single largest vessel of sulfur dioxide on-site) and 24 x 150 pound cylinders.

The processes for the HHC's stored and handled at the facility are summarized below:

1. Chlorine is repackaged from railcars into 2000 pound containers and or 150 pound cylinders.

2. Chlorine is used in the manufacture of sodium hypochlorite (bleach).

3. Sulfur dioxide is used in the manufacture of sodium bisulfite.

All the HHC's are hazardous materials as defined by U.S. Department of Transportation (DOT). Thus, all containers and transportation equipment are regulated by the DOT.

This PHA has been prepared by and reviewed by the JCI Corporate Environmental, Safety and Risk Management Departments, and the facility's PHA team.

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SECTION 2
FACILITY DESCRIPTION

2.0 Facility Description

JCI began operations at the Merrimack, New Hampshire facility in 1964. The following description of facility operations is based upon currently existing conditions.

2.1 Facility Location and Layout

The JCI facility is located in Hillsborough County on a 7 acre parcel of land at 40 Railroad Avenue, Merrimack, New Hampshire. Currently, the facility is bounded by industrial property to the north, south and west. There are railroad tracks and industrial property to the east. The facility is surrounded primarily by industrial areas, however, there are residential areas located approximately 0.25 miles to the northwest of the facility.

2.2 Facility Profile

The facility currently has 11 full time and 1 part time employees that include management, production, drivers, maintenance and clerical personnel. The plant is in operation from 5:00 am – 5:00 pm Monday through Friday and the office is in operation from 7:00 am – 5:00 pm Monday through Friday.

The facility has 2 buildings. The primary building is a production facility and the other building is facility's main offices.

2.3 Site Topography and Meteorological Conditions

Most of the facility is located on level land, approximately 124 feet above sea level. The area receives precipitation approximately 180 days per year. Average annual precipitation is 40 inches. The average wind speed is 5 miles per hour. Temperatures average 25°F in January, the coldest month of the year. Summer temperatures average 81°F, though summer temperatures sometimes approach 100°F.

2.4 Site Access

Entrance to the facility by motor vehicle is controlled by an automated gate and fence. The Pan-Am Railway is located on the east side of the facility. A rail spur enters the facility for railcar delivery of chlorine and sodium hydroxide solution.

2.5 Regional Demographics

The facility is located in an industrialized area. Neighboring properties include Thompson Performance which is 100 yards to the north, D&D Cota Industrial Park LLC which is 150 yards to the north, Straight Line Machining which is 200 yards to the north, Gleason/Iverson Stone Suppliers, Inc. which is 20 yards to the east and Trans-Support which is 20 yards to the east.

2.6 External Events of Concern

Given that this facility is located in the Northeast, it is subject to heavy snow and possible blizzards in the winter and heavy rains during the rainy season. This facility is 55 miles inland and just barely located in the 100-year flood plain.

2.7 Facility Siting

Facility Siting, sometimes referred to as Stationary Source Siting, pertains to the requirement to consider the location of covered processes on Branch property relative to the potential impact on both onsite and offsite receptors, and of the risks associated with the release of any regulated substance from these processes. Included in these risks are the consequences of the mixing of incompatible materials. These factors were considered both in determining where products handled by JCI Jones Chemicals, Inc. would be repackaged and stored so as to minimize if not prevent the mixing of incompatible products and in the development of both the Worst and Alternate Case Scenarios in accordance with the EPA's Risk Management Program regulations and are discussed in detail in the Merrimack branch's Risk Management Plan. The following factors pertaining to Facility Siting were also considered during this Process Hazard Analysis:

- Are storage, use and transfer areas not located uphill from adjacent operations?

- Are storage, use and transfer areas located away from sewer openings and other underground structures if present?
- Do storage, use and transfer areas have easy access for emergency response?
- Are storage, use and transfer areas free of combustible or incompatible materials and isolated from hydrocarbons?
- Are storage, use and transfer areas downwind of or separated from most operations and support areas and ventilation intakes based on prevailing wind direction?
- Are storage, use and transfer areas isolated from sources of corrosion, fire and explosion and protected from vehicle impact?
- Are storage, use and transfer areas located away from residences and facility boundaries?
- If cylinders and containers are stored outside, are the protected from impact by vehicular traffic?

In addition, the “What If?” Process Hazard Analysis contained in Sections 11 and 12 of this document reflect consideration of the location of the repackaging, storage and distribution phases of each covered process.

Lastly, Section 6 (Detection and Monitoring) of this document discusses the various mitigation systems that have been installed at the Merrimack facility which serve to reduce the potential for catastrophic releases of the Highly Hazardous Chemicals handled at the facility.

SECTION 3
HIGHLY HAZARDOUS CHEMICAL PROCESSES

3.0 Introduction

The facility handles two highly hazardous chemicals: chlorine and sulfur dioxide. This section briefly discusses each chemical and the process associated with it. A more complete discussion is contained in the JCI Production (PR) Manual.

3.1 Chlorine

These processes include the repackaging of chlorine, the storage and distribution of chlorine, and the manufacturing of sodium hypochlorite (bleach).

3.1.1 Chlorine Repackaging

The chlorine repackaging process at the facility includes repackaging chlorine and the production of sodium hypochlorite (bleach). Detailed descriptions and schematic diagrams of the storage and handling of chlorine at the facility are included in the facility's Process Safety Management files.

The facility receives chlorine in railcars. Each railcar is typically a 90-ton U.S. Department of Transportation (DOT) specification chlorine tank car. The railcars are used for storage. Railcars are delivered by Pan-Am Railway via a spur line. The spur provides storage for railcars. The spur generally contains no more than five 90-ton chlorine railcars, although there is room for additional railcars of chlorine. Typically, when a railcar is delivered, an empty one is removed.

Chlorine is repackaged from a railcar into 2000 pound containers and 150 pound cylinders. Chlorine as a liquid (as contrasted to gas) is transferred from the railcar using air pressure. The plant air used to pressurize (pad) the railcar is supplied by an air compressor and must be dried to -40°F dew point. Air pressure of approximately 180 pounds per square inch (psi) is used to pad the chlorine railcar.

Liquid chlorine is forced out through a 1-inch carbon steel line. Chlorine is transferred through this line to a header, which distributes the chlorine to the cylinder and ton filling stations, and to the bleach production area. The pressure at the filling stations averages 140 psi.

In preparation for filling, returned chlorine containers and cylinders are blown down, a vacuum is applied, and the valve(s) removed. A rebuilt or new valve is installed.

The liquid and gas vapor from the blown-down operations is transferred through a closed-loop system to the chlorine blow-down tanks for use in the manufacture of sodium hypochlorite. The gas vapor from vacuum operations is transferred through a closed-loop system to the vacuum ton for use in the manufacture of sodium hypochlorite.

Valves are rebuilt on site by disassembly and inspection and cleaning of all parts both internally and externally by mechanically driven brushes. They are then re-inspected, reassembled, and pressure-tested at 500 psi with nitrogen in a water bath.

Once the new or rebuilt valve is installed, the container is positioned on a scale to be filled with liquid chlorine. The filling station allows for liquid filling as well as product removal by closed-looped blow-down and vacuum systems. Each scale is equipped with an automatic scale shutoff when the scale has reached a pre-programmed weight. The scales are checked daily using a container of known weight. An outside contractor, Advance Scale Company, checks the scales annually.

Containers are hydrostatically tested every five years in accordance with DOT specifications.

All chlorine handling equipment in use at the facility complies with recognized and generally accepted good engineering practices.

3.1.2 Chlorine Storage and Distribution

Full containers are stored for subsequent distribution to customers by tractor-trailer. All drivers and members of the yard crew are trained in loading and unloading these containers.

In some instances, customers use their own trucks to return empty and pick up full containers. Common and contract carriers may also be used for chlorine delivery if needed.

Containers are hydrostatically tested every five years in accordance with DOT specifications.

All chlorine handling equipment in use at the facility complies with recognized and generally accepted good engineering practices.

3.1.3 Manufacture of Sodium Hypochlorite (Bleach)

Bleach Made Via Bleach Machine

Sodium hypochlorite is produced at a strength of 12.5 percent by reacting chlorine with dilute sodium hydroxide (caustic soda). A bleach machine at this facility produces bleach in a continuous process that is operated as needed. Chlorine and 50% caustic soda are piped to a machine where they react and are diluted with water to the desired strength. The machine has electronic controls to monitor and control the process. The finished product is pumped either to bulk storage tanks or directly into a tank truck for delivery.

All sodium hypochlorite handling equipment in use at the facility complies with recognized and generally accepted good engineering practices.

Bleach Made Via Batch Method

Sodium hypochlorite is produced at a strength of 12.5 percent by reacting chlorine with dilute sodium hydroxide (caustic soda). The dilute caustic soda is circulated through a pump system as chlorine is injected into the solution. Monitoring devices are used to verify the finished product. The finished product is pumped either to bulk storage tanks or directly into a tank truck for delivery.

Vapors generated by degassing (blowing down) returned chlorine containers and cylinders and the blow-down and vacuum steps that occur during chlorine container and cylinder filling operations are piped to collection tanks (surge tons) and then to vats that contain a dilute solution of sodium hydroxide. The chlorine reacts with the caustic soda to produce bleach. In addition, chlorine from the railcars can also be piped to these vats. When the reaction is complete, the solution is then pumped to bulk storage tanks or directly into a tank truck for delivery.

From storage, the bleach is pumped to containers for shipment. Transfer is through schedule 80 polyvinyl chloride pipes and by polyethylene transfer hoses. Bleach is shipped in 15- and 55-gallon drums, 220- and 330-gallon totes, as well as by DOT specification lined tank trucks.

All sodium hypochlorite handling equipment in use at the facility complies with recognized and generally accepted good engineering practices.

3.2 Sulfur Dioxide

These processes include the storage and distribution of sulfur dioxide and the manufacturing of sodium bisulfite.

3.2.1 Storage and Distribution of Sulfur Dioxide

Full containers are stored for subsequent distribution to customers by tractor-trailer. All drivers and members of the yard crew are trained in loading and unloading these containers.

In some instances, customers use their own trucks to return empty and pick up full containers. Common and contract carriers may also be used for sulfur dioxide if needed.

Containers are hydrostatically tested every five years in accordance with DOT specifications.

All sulfur dioxide handling equipment in use at the facility complies with recognized and generally accepted good engineering practices.

3.2.2 Manufacture Of Sodium Bisulfite

Sodium bisulfite is produced by reacting sulfur dioxide with dilute sodium hydroxide (caustic soda) in a reaction vessel. The process begins at a pH of 12.5 SU and during the process, the solution transitions from dilute sodium hydroxide to sodium bisulfite with a final pH of approximately 3.5 SU. Both the pH and temperature of the solution are monitored via a pH/temperature control system equipped with audio alarms designed to sound in the event established parameters applicable to each are exceeded. Once the pH of the solution drops to 6.0 SU, a "scrubber system" is activated, the sole purpose of which is to absorb and therefore prevent the release of any fugitive fumes generated during the production process. The scrubber system is an 18” PVC Vertical Fume Scrubber specifically designed for the sodium bisulfite production process and again, is activated during the second half (lower pH) of the manufacturing process when the solution has transitioned from sodium hydroxide to sodium bisulfite.

All sodium bisulfite handling equipment in use at the facility complies with recognized and generally accepted good engineering practices.

SECTION 4
CHEMICAL HAZARDS

4.0 Overview of Chemical Hazards

There are Safety Data Sheets (SDSs) or Material Safety Data Sheets (MSDS) available for all chemicals on site covered by the OSHA Hazard Communication Standard. A complete set is kept in the main office and in the plant break room. The Branch Manager has the responsibility for ensuring that SDSs or MSDSs are current. The Highly Hazardous Chemicals handled at the facility are all classified as hazardous materials by the US Department of Transportation (DOT). This means that the containers used to ship the HHC's are regulated by the DOT. Following is a very brief overview of the hazards of the HHC's and their processes at this facility.

4.1 Chlorine (Cl_2)

Chlorine (CAS #7782-50-5) is a greenish yellow gas with a pungent suffocating odor, detectable at concentrations of 0.5 ppm or less. Its boiling point is -30.3°F. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value 8-hour time-weighted average (TWA) of exposure to chlorine at 0.5 ppm. ACGIH has established a threshold limit value short-term exposure limit (STEL) of 1 ppm for exposure to chlorine. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) ceiling concentration is 1 ppm. In 1994, the National Institute for Occupational Safety and Health (NIOSH) reduced its Immediately Dangerous to Life or Health (IDLH) concentration for chlorine to 10 ppm. The DOT and EPA reportable quantity (RQ) value is 10 pounds. The DOT classifies it as Division 2.3 (Poison Gas), and as a Poison Inhalation Hazard, Zone B.

Chlorine is a poison gas stored under pressure as a liquid. The vapors are heavier than air and tend to settle in low areas. It is corrosive to eyes, skin and mucous membranes in the presence of moisture. It may be fatal if inhaled. Do not breathe air containing chlorine. Do not get chlorine in eyes, on skin, or clothing. Keep containers away from intense heat or open sunlight. It is corrosive to most metal in the presence of water.

4.2 Sodium Hypochlorite (NaOCl)

Note: Sodium hypochlorite is not listed under OSHA's Process Safety Management Standard however because the HHC chlorine is used as a raw material for the production of sodium hypochlorite at the facility, JCI conducted a PHA for this process.

Sodium hypochlorite (CAS #7681-52-9) is a greenish yellow liquid with a characteristic odor. The DOT and EPA reportable quantity (RQ) value is 100 pounds. The DOT classifies it as Class 8 (Corrosive), Packing Group III.

Sodium hypochlorite decomposes naturally. Contact with acids will liberate chlorine that is irritating to eyes, lungs, and mucous membranes. Contact with other chemicals or organic matter may liberate chlorine or other harmful gases. It is corrosive and may cause severe skin irritation or chemical burns to broken skin. It causes eye damage, and is toxic to fish.

4.3 Sulfur Dioxide (SO_2)

Sulfur dioxide (CAS #7446-09-5) is a yellow gas with a pungent suffocating odor, detectable at concentrations of 3-5 ppm. Its boiling point is 14°F. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) concentration is 5 ppm as an eight-hour time weighted average (TWA). The NIOSH Immediately Dangerous to Life or Health (IDLH) concentration is 100 ppm. The EPA (SARA Title III) reportable quantity (RQ) value is 500 pound. There is no DOT RQ. The DOT classifies it as Division 2.3 (Poison Gas), and as a Poison Inhalation Hazard, Zone C.

Sulfur dioxide is a gas stored under pressure as a liquid. The vapors are heavier than air and tend to settle in low areas. It is intensely irritating to the eyes and respiratory tract causing burning of the eyes and tearing, coughing and chest tightness. It may cause severe breathing difficulties.

4.4 Sodium Bisulfite ($NaHSO_3$)

Note: Sodium bisulfite is not listed under OSHA's Process Safety Management Standard however because the HHC sulfur dioxide is used as a raw material for the production of sodium bisulfite at the facility, JCI conducted a PHA for this process.

Sodium bisulfite (CAS #7631-90-5) is a light, straw colored liquid with a sulfur dioxide odor. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) concentration is 5 mg/m^3 as an eight-hour time weighted average (TWA). The DOT and EPA reportable quantity (RQ) value is 5,000 pounds. The DOT classifies it as Class 8 (Corrosive), Packing Group III.

Sodium bisulfite solutions are acidic. It causes eye, skin and respiratory tract irritation.

SECTION 5
DESIGN

5.0 Design Controls

Prevention of HHC releases requires proper design. This facility has been designed with a number of features to prevent and control potential HHC releases. This section presents a description of the release detection, prevention, and control measures at the facility. The chlorine system has been designed based on the recommendations of the Chlorine Institute. Further details are available, including reference documents, in the facility’s Process Safety Management files.

5.1 Release Prevention Control Systems

The United States Department of Transportation (DOT) regulates both the allowable containers that can be used for the HHC's and their design. The DOT regulations are found in Title 49 Code of Federal Regulations.

Various release prevention devices are incorporated into the design of rail cars utilized to transport chlorine or sulfur dioxide to the facility and into the design of containers/cylinders into which the gases are repackaged.

5.1.1 Rail Cars

The tank cars that may be utilized for the HHC's at this facility are contained in the DOT regulations at 49 CFR 173.314. The specifications for single unit tank car tanks are contained in the DOT regulations at 49 CFR 179.100.

5.1.1.1 Pressure Relief Valves

A pressure relief valve is located on the top of the rail car in the center of the man way cover. It is designed to vent when the internal rail car tank pressure exceeds 225 psig for type 105A300W rail cars or at 375 psig for type 105A500W rail cars. The venting of either chlorine or sulfur dioxide vapor in this manner prevents a major buildup of pressure within the rail car's tank that could result in a catastrophic failure. Once pressure is reduced below the set point the valve re-seats. This minimizes the amount of vapor released.

5.1.1.2 Excess Flow Valves

Under each liquid valve there is an excess flow valve. The excess flow valve consists of a rising ball which closes its valve when the rate of flow exceeds 7,000-pounds/hour, 11,000-pounds/hour, or 15,000-pounds/hour depending upon the type of rail car. The operation of this valve is not dependent upon the internal pressure of the rail car tank. Rather, it is designed to close automatically against an excessive flow of liquid.

5.1.2 Ton Containers (Multi-Unit Tank Car Tanks)

Ton containers are regulated by the DOT as multi-unit tank car tanks, even though they are usually transported by truck. The multi-unit tank car tanks that may be utilized for chlorine or sulfur dioxide at this facility without a special permit are listed in the DOT regulations at 49 CFR 173.314(c) and 173.23(a). The specifications for multi-unit tank car tanks are contained in the DOT regulations at 49 CFR 179.300.

5.1.2.1 Pressure Relief

All ton containers are equipped with fusible metal pressure relief devices. Most have six fusible metal plugs, three on each end, spaced 120° apart. The fusible metal is designed to melt between 158°F and 165°F to relieve pressure and prevent rupture of the container in case of fire or other exposure to high temperature.

The ends of the containers are concave, designed to "bulge" when over-pressured thus increasing their capacity. They are hydrostatically tested every five years to 500 psi. They are filled by weight to 80% of water capacity. At 155°F, ton containers would be skin full of liquid.

5.1.3 Cylinders

The cylinders that may be utilized for the HHC's at this facility are contained in the DOT regulations at 49 CFR 173.304a (a)(2). The specifications are contained in the DOT regulations at 49 CFR 178, Subpart C.

5.1.3.1 Pressure Relief

All cylinders are equipped with a fusible metal pressure relief device. Most valves have a threaded plug containing the fusible metal screwed into a tapped hole in the valve body, below the valve seat. The fusible metal is designed to melt between 158°F and 165°F to relieve pressure and prevent rupture of the container in case of fire or other exposure to high temperature.

Chlorine and sulfur dioxide cylinders are hydrostatically tested every five years to 500 psi. They are filled by weight to 80% of water capacity.

5.1.4 Piping System

5.1.4.1 Material of Construction

The piping used for chlorine and sulfur dioxide is carbon steel per ASTM A 106-90, Grade A or B, 3/4 inch to 1 1/2 inch Schedule 80.

An in-service corrosion test has been conducted for the corporation. After at least three years of chlorine service under normal operating conditions, the pipe meets the tolerances for new pipe. The corrosion rate for test coupons was calculated as outlined in ASTM G 1-90 to be less than one (1) mil per year, correlating to a 10-year inspection or replacement interval for the pipe to remain within specification.

5.1.4.2 Expansion Chambers

There are expansion chambers in the liquid chlorine and sulfur dioxide systems piping to prevent a piping rupture if liquid chlorine and/or sulfur dioxide were to be trapped between isolation valves and subsequently expands. These expansion chambers are located between isolation valves in any piping run that is over 100 feet long.

5.2 Isolation Systems

5.2.1 Valves

Other release prevention devices include isolation systems. Flow control valves are placed at strategic locations throughout each

HHC process to direct the HHC flow depending upon plant operating conditions. These flow control valves also serve to isolate portions of the system in the event of component malfunction or line failure. Thus, rail cars, filling stations, and various transfer line segments can be isolated by operating strategically located valves.

Quick shutoff valves are installed on both ends of the chlorine supply piping.

5.2.2 Barometric Loop

There is a barometric loop between the chlorine tank car and the bleach vats to prevent bleach and caustic from backing up into the chlorine supply system from the bleach vats.

5.3 Release Containment Systems

5.3.1 Diking

Release containment devices incorporated into the design of the plant are primarily for spill containment. Storage tanks containing alkaline materials such as sodium hypochlorite and sodium hydroxide, and storage tanks containing acidic materials such as sodium bisulfite, where applicable, are located in separate concrete containment areas (dikes) designed to hold a minimum of 110% of the contents of the largest tank.

Dikes are employed throughout the facility wherever liquids are handled or stored.

5.3.2 Vent Scrubbers

The facility has vent scrubbers to control fugitive emissions to the atmosphere. The emissions from sodium hypochlorite manufacturing are absorbed in dilute caustic soda that is then reused in bleach production. The emissions from sodium bisulfite manufacturing are absorbed in dilute caustic soda that is then reused in sodium bisulfite production. The scrubber system is an 18” PVC Vertical Fume Scrubber specifically designed for the sodium bisulfite production process and is activated during the second half (lower pH) of the manufacturing process when the solution has transitioned from sodium hydroxide to sodium bisulfite.

5.4 Fire Protection System

Fire extinguishers are located throughout this facility. A complete list of the location and type of fire extinguishers is contained in the facility’s Contingency Plan. The facility has a sprinkler system.

SECTION 6
DETECTION AND MONITORING

6.0 Introduction

The facility has a number of detection and monitoring devices (i.e., mitigation systems) that minimize the risk of incidents involving HHC's. These include:

6.1 Vacuum Alarm System

The vacuum alarm system is designed to alert Plant employees in the event that the vacuum system fails; i.e., the chlorine and or sulfur dioxide lines are positively pressurized. This can occur as a result of excessive pressure being applied through the vacuum system; i.e., feeding liquid chlorine directly into the vacuum line, or if the vacuum pump shuts down. The loss of this vacuum capability, in the repackaging process, presents several opportunities for accidental product release and particularly while unhooking railcars and containers, notwithstanding other precautionary devices (gauges). The design is simple; a pressure switch (set at 1 lb. PSI for both chlorine and sulfur dioxide) constantly monitors the vacuum line for a vacuum at the point of entry on the fill station side of the vacuum surge ton (vacuum reservoir). If a vacuum is lost due to error or malfunction, the pressure switch will activate an automatic shut-off valve in the vacuum line and activate an audible alarm to alert operators of this abnormal production condition. The fill and process manifolds present the only opportunity for the vacuum line to be positively charged with either chlorine or sulfur dioxide gas. The activation of this alarm does not indicate a release or an emergency condition. An activation of this alarm does, however, provide notification of an abnormal condition and therefore, requires immediate operator and supervisory attention to determine the cause.

The operator(s) will then suspend unhooking containers until a vacuum is restored. As the pressure in the vacuum ton drops, the pressure switch will read this and send a signal to the solenoid that will then open the actuated valve. This process will be automatically repeated until a vacuum has been reestablished in the transfer system. The alarm parameters are as follows:

Chlorine	1 PSI
Sulfur Dioxide	1 PSI

6.2 Vat Control System

The vat control system is designed to prevent over-chlorination or over-sulfonation of the bleach and sodium bisulfite make vats respectively, during the manufacturing process. The vat control system monitors both the excess caustic and pH in the bleach blow vat and sodium bisulfite make vat systems respectively as well as the temperature of the product in both systems during the production process and works in two stages. Stage one rings a "production alarm" when the vat has reached pre-set ORP/pH and or temperature readings. The operator then manually shuts down the flow of chlorine or sulfur dioxide, depending on the product being made. The second stage of this system consists of an "emergency shutdown" and also includes an audible alarm. While the set-points for bleach and sodium bisulfite production are set well below and above the product conditions that would cause over-chlorination or over-sulfonation respectively, the system itself will automatically close all actuated valves thereby stopping the flow of chlorine or sulfur dioxide into the vats once the second set of pre-set ORP/pH and or temperature parameters are met. The system is designed such that it cannot be manually reset or overridden as long as the "emergency shutdown" parameters exist. The parameters listed below are fairly representative of those at each JCI facility but it's important to point out that these settings are not identical at all JCI facilities.

	Production Alarm	Shutdown
Bleach	500 mv (ORP)/85°F	560 mv (ORP)/95°F
Sodium Bisulfite	5.0 s.u. (pH)/110°F	3.5 s.u. (pH)/120°F

As with the railcar monitors, the vat control system must be secured so as to prevent access to either the electrical components inside the cabinets themselves and/or the ORP/temperature controller and pH/temperature settings for the bleach blow vat and the sodium bisulfite make vat systems respectively by anyone other than maintenance personnel and or personnel authorized by the Branch Manager.

Note: In the event of a shutdown due to a chlorine or sulfur dioxide release, we want to retain the ability to open the actuated valves in the blow or liquid lines at the blow (bleach) or make (bleach or sodium bisulfite) vat(s). In order to accomplish this, it is mandatory that a "bypass" switch be installed that can be used to open the actuated valve in either system in order to avoid a pressure buildup in the piping system. The exception to this of course is if the leak is in the system <u>after</u> the actuated valves; i.e., in the sparger tube(s).

6.3 Gas Detection System

The railcar monitoring and plant sensors systems are designed to identify a release of chlorine and/or sulfur dioxide either at the railcar(s) or throughout the Plant and shut down the flow of product at its source (i.e., the railcar, filling stations, container storage area, etc.). **Note:** *The activation of any of the manual e-stops strategically located throughout the Plant will also serve to shut down the flow of product from the railcars to the filling stations, bleach machine (if applicable), and the blow/make vats.* The key component of the gas detection system is the sensors located in close proximity to each railcar, production, and storage areas. The sensors are programmed with two settings as referenced below; a "warning" condition and a "shutdown" condition. If a release is detected, the system will sound an alarm indicating that the "warning" condition has been achieved. Should the release meet the pre-established "shutdown" conditions, the actuated valves on the railcar, the airlines going into the railcar, the header valve on the main manifold leading into the Plant, and all actuated valves, excluding that on the vacuum alarm system, in the chlorine and sulfur dioxide piping systems throughout the entire Plant will close. The alarms sound and the valves close at the following settings:

	WARNING	SHUTDOWN
Chlorine	0.5 ppm	1.0 ppm
Sulfur Dioxide	2.5 ppm	5.0 ppm

It is important to keep in mind that the conditions that set off the alarms in the first place must be identified and addressed <u>before</u> resetting the system. It is appropriate to note here that the "warning" parameters may be either "latching" or "non-latching" dependent on system equipment design. In a "latching" configured system, the system must be manually reset but at the same time, can only be reset after the condition causing the alarm has gone away whereas in a "non-latching" system, the system will reset itself automatically when the condition identified by the sensor goes away. It is also appropriate to note here that the "shutdown" parameters must be latching. The monitor itself should be secured so as to prevent access to the settings. A "remote" reset button should be mounted externally to the monitor which will eliminate the need to gain access to the system settings unless absolutely necessary. It should be understood that with the exception of maintenance personnel performing system checks or maintenance on the monitors and or designated employees so authorized by the Branch Manager, no one should be permitted to alter system settings.

6.4 Plant Emergency Stops (E-Stops)

In addition to the mitigation system components discussed above that electromechanically monitor and detect shutoff conditions, it may be necessary to initiate a shutdown condition based on prudent and necessary operator observation. For this reason, each JCI facility has installed several Plant Emergency Stops (E-stops or Panic Buttons) that are tied directly into the existing gas mitigation systems. The activation of this system triggers an audible and/or visual alarm. By pushing one of these buttons, an employee can shut down every actuated valve in the entire chlorine and sulfur dioxide transfer system(s) with the exception of the vacuum alarm. Clear and unobstructed access to these buttons is to be maintained at all times. They must also be clearly marked and all employees must be made aware of the location of the E-stop closest to their work stations. Ideally, the E-stops should be located at the primary egress routes from the production building(s).

6.5 Backflow Prevention System

The purpose of the backflow prevention system is to prevent chlorine or sulfur dioxide from coming back into the "pad" air system and compressor. Being a compressed gas, there is always pressure on a railcar. If the Plant "pad" air system should lose pressure, it would be possible that the car pressure could exceed that of the "pad" air system thus allowing product to back up into the air system. The system is comprised of two (2) actuated valves, a solenoid valve, two (2) pressure differential switches, one pressure switch and a control panel. The pressure differential switches are designed to maintain a pressure differential of greater than or equal to 5 psi on the compressor side relative to the railcar side. The purpose of the pressure switch is to shut off both actuated valves when the pressure at the railcar has reached the pre-determined set point. A pressure differential of less than 5 psi will close both actuated valves. In order for the actuated valves to remain open, both conditions; a pressure differential greater than or equal to 5 psi and less than the pre-determined set point on the railcar side, must exist; otherwise, both valves will remain closed.

Pad Air Side: At least 5 PSI greater than the railcar side.

6.6 Auto-Dialer Alert System

The auto-dialer alert system is designed to augment the Gas Detection System. This system is tied into the gas detection system and specifically the “warning” parameter such that during non-working hours and in the event the “warning” parameter is achieved, a pre-programmed sequence of Branch employee phone numbers will be dialed to provide notification that a sensor has detected gaseous fumes of some type. The responding employee will acknowledge the notification via phone and report to the Branch to determine the source of the problem. As discussed above in Section 6.3 (Gas Detection System), the “warning” parameter may be either “non-latching”; i.e., the alarm will cease to sound on its own when the condition causing the alarm to sound in the first place has gone away or “latching”, meaning that the system must be manually reset but can only be reset after the condition causing the alarm to sound in the first place has gone away.

6.7 Ultrasonic Tank Level Monitoring System

All product tanks, to include both storage and production (make) vats, are equipped with ultrasonic tank level monitoring systems. The tank-level monitoring system is designed such that low-level and high-level audible alarms will alert an operator when the tank has reached its pre-set low condition and or high condition set points. In the event of a low level condition, the alarm will help to ensure that pumps are not run dry, thereby damaging them and resulting in costly repairs. The low level condition alarm will signal the need to switch to another tank, shut down the process, or either produce or order more product. Lastly, it will serve as a warning in the event of a tank failure.

The high-level alarm will alert the operator that the tank is almost full or has the desired amount of product in the tank and therefore serves to prevent the tank(s) from being overfilled.

Note: The following points apply to the three mitigation system components discussed above in Sections 6.1, 6.2, and 6.3.

a. Once a shutdown condition is reached and the system has shutdown, it cannot be reset until the condition causing the activation has been satisfactorily corrected or eliminated.

b. The control panels (quad scans, XPLs, DPLs, ORP/pH controllers) must be secured so as to prevent tampering or unauthorized adjustments to the pre-set parameters by anyone other than either maintenance personnel or employees designated by the Branch Manager, again, while in the course of performing system checks or required maintenance.

c. Systems must be installed in a location such that unobstructed access and viewing is always provided.

d. Systems must be configured such that a controller cannot be reset as long as the condition initiating the shutdown continues to exist.

6.8 Automatic Scale Shut-off

The purpose of this system is to prevent either a ton or cylinder from being overfilled during the filling process. All ton and cylinder scales operate actuated valves that will shut off the flow of chlorine or sulfur dioxide when the scale has reached a pre-programmed weight. The weight is pre-programmed by the operator and is dependent on the amount of product desired. This system is also equipped with a panic button that will allow an operator to shut down the supply of chlorine or sulfur dioxide to the manifold in case of an emergency. There are a couple of points that should be addressed with those employees responsible for filling tons and cylinders. First, the set points should be checked daily while conducting the scale check. It is important that the indicator is "zeroed" each time before placing the next container onto the scale. To ensure accuracy, the weight reflected on the indicator after connecting the container should be "zeroed" (tare weight) again prior beginning to fill the container. **Note**: At no time during the filling process should the operator leave the area.

6.9 Railcar Valve Closure System

The Rail Car Valve Closure System is the most recent addition to our ongoing effort to ensure that JCI Jones Chemicals, Inc. has the most updated, sophisticated and comprehensive mitigation system possible in place at our Branches. As opposed to stopping the flow of either chlorine or sulfur dioxide through specific or isolated sections of the compressed gas (chlorine and or sulfur dioxide) transfer system via isolation valves, the sole purpose of the Rail Car Valve Closure System is to immediately stop the flow of chlorine and or sulfur dioxide through the transfer system by automatically closing the liquid valve(s) at the source; i.e., a railcar in the event of a gas release achieving pre-established "shutdown" conditions, a low air pad condition, a power failure or if an e-stop is depressed, regardless of the reason.

Note: As discussed in Section 6.3 (Gas Detection System), the "shutdown" parameters are 1.0 ppm for chlorine and 5.0 ppm for sulfur dioxide.

In addition to eliminating the possibility of the continued unloading of chlorine or sulfur dioxide from the railcar in the event any of the conditions described above are met, it is worth noting that a secondary and equally important purpose of this system is to improve the level of security at the Branch by reducing the vulnerability of our railcars. The effectiveness of an attack against a railcar will be significantly diminished if product is not flowing from the railcar.

After the Railcar Valve Closure System has been activated, chlorine and or sulfur dioxide can only be supplied to the transfer system again after the liquid valves on the railcar have been manually opened by a JCI employee.

SECTION 7
OPERATIONS

7.0 Standard Operating Procedures

JCI has developed and implemented standard operating procedures (SOPs) for the operation of each HHC process. These procedures include an SOP for product filling and transfer, an SOP for Railroad operations, an SOP for Compressed Gas Container Testing and Inspection, and an SOP for Repackaging of Compressed Gases. These SOPs are contained in the JCI Production Manual and the JCI Mechanical Integrity Manual.

No locally prepared instructions, other than a part of the Contingency Plan, are available since all JCI facilities are essentially similar in process and products. Local input is solicited on changes and new best practice procedures before they are enacted corporate wide. These detailed manuals were first issued in 1988 to consolidate information and are updated on an as needed basis.

7.1 Department of Transportation (DOT) Regulations

The HHC's handled at this facility are Hazardous Materials as defined by the DOT. The DOT regulations are found in Title 49 Code of Federal Regulations (49 CFR).

7.1.1 Compressed Gas Containers

The HHC compressed gas containers (including rail cars) are all regulated by DOT. The regulations include requirements for manufacture, use, and visual inspection. Chlorine and sulfur dioxide containers must be hydrostatically tested every five years. Cylinders must be retested by a certified retester at 5/3 service pressure (800 pounds). Ton containers are retested to their service pressure, 500 pounds.

The regulations specify the filling density as a percent of water capacity verified by weight.

To assure compliance with these regulations, the facility tracks all containers by their serial number when testing, filling and shipping. The scales are checked daily using a container of known weight. An outside contractor services the scales annually.

7.1.2 Liquid Containers

The liquid containers for HHC process chemicals are all regulated by the DOT. These regulations include drums as well as tank trailers.

7.2 Shut Down Procedure

When the plant is not in operation, the rail cars are disconnected. Gas in the pipelines is removed through the vacuum systems.

7.3 Equipment Inspection and Maintenance Program

A program of periodic equipment inspection and maintenance has been implemented. This program consists of a variety of inspection grid maintenance frequencies and procedures ranging from rounds of the plants conducted on every shift to annual instrumentation testing of major equipment. Inspection requirements are detailed in the JCI Mechanical Integrity Manual.

The facility uses a manual work order system for routine maintenance. One employee is dedicated to maintenance for routine repairs. Outside contractors are used for servicing forklift, air compressors, scales, fire extinguishers, electrical work, and other major projects. Servicing is done according to JCI’s specifications.

7.4 Color Code

All piping and containers are color coded to facilitate immediate identification.

7.5 Backups and Redundancy

See Section 6 – Detection and Monitoring.

No emergency generator or other backup power system is provided for a general power failure. All operations would be shut down and disconnected.

Excess caustic is always maintained in a vat to absorb either chlorine or sulfur dioxide from the respective blow down piping when filling cylinders and containers.

There is diking and berms around tanks and truck loading and unloading stations.

7.6 Site Security Program

JCI has an extremely comprehensive Security Plan written in accordance with guidance provided by the Corporate Office, the Department of Transportation's regulations pertaining to security (HM 232) dated March 25, 2003; the Department of Homeland Security's Chemical Facility Anti-Terrorism Standards (6 CFR 27) issued on April 9, 2007 and the Transportation Security Administration's Rail Transportation Security Regulations (49 CFR Parts 1520 and 1580) dated November 26, 2008. The purpose of the JCI Jones Chemicals Inc. Security Plan is to establish a policy and standard operating procedures which will not only serve to enhance employee awareness with respect to security issues but minimize the potential impact on JCI personnel, facilities, equipment, processes and products as a result of unlawful acts either made or attempted by individuals seeking to harm personnel, property and or the environment. As stated in our Security Policy, we are committed to the continuous improvement of this program and will make every effort to develop and implement measures designed to maintain the highest level of security possible at all JCI facilities.

JCI's Security Plan covers a broad spectrum of topics and scenarios, to include the control of visitor access to the Branch and or Corporate Office. In accordance with JCI's Security Plan, no visitors are allowed onto Branch property without a prior appointment approved by the Branch Manager. Visitors permitted onto Branch property are required to register at the plant office and record their name, company or organization represented, purpose of the visit, time in and time out in the Visitor's Log. If they are visiting the plant, our Safety rules must be explained to them and they must be provided with a Visitor's Pass as well as personal protective equipment; i.e., safety glasses and an escape respirator.

SECTION 8
SAFETY, HEALTH, and ENVIRONMENTAL MANAGEMENT

8.0 Safety, Health, and Environmental Program

Safety and environmental issues are coordinated by the JCI Corporate Office.

The safety and health program is contained in the JCI Safety Manual and the JCI Safety Training Manual. The environmental program is contained in the JCI Environmental Manual and the JCI Quality Manual.

Fire extinguishers, gas masks, eyewash, and shower stations are located throughout the facility. Employees are required to wear side-shield safety glasses, bump caps (optional), and steel-toed shoes, and carry escape respirators. Additional function specific personal protective equipment is provided as required.

8.1 Facility Role in Process Safety Management

Daily safety and environmental matters are handled at the local level by the Branch and Plant Managers. All employees must attend a monthly safety training meeting. Employee suggestions are welcomed and encouraged.

8.2 Accident Prevention Program

JCI has a very comprehensive Accident Prevention Program which is contained in Chapter XII of the JCI Safety Manual. The purpose of this program is the elimination of all accidents. It consists of two parts: 1) hazard control and 2) accident investigation and review. The purpose of hazard control is to identify workplace hazards before they cause an accident. Accident investigation and review determines the causes of accidents and finds ways to eliminate these causes in order to prevent a recurrence. Together, hazard control and accident investigation and review increase the safety of the workplace.

8.2.1 Hazard Control

The effectiveness of JCI's Accident Investigation Program is due in large part to identifying and eliminating hazards well before an accident occurs in the first place. All employees are expected to take a proactive role with respect to being aware of, identifying, and reporting conditions and or situations of any type that can result in an accident and or injury. Hazard control procedures can be broken down into three steps: 1) Hazard Identification, 2) Hazard Review Process, and 3) Elimination of Hazards.

8.2.1.1 Hazard Identification

A hazard can be categorized as either an unsafe condition and or act that can result in an accident and subsequent injury to employees and or damage to equipment. Based on the premise that no hazard and or potential hazard is considered to be insignificant, the condition and or act identified is to be either immediately corrected or eliminated if safely possible and if not, it is to be reported in accordance with JCI's Hazard Reporting Procedures on the JCI Hazard Report Form.

8.2.1.2 Hazard Review Process

All Hazard Report Forms will be reviewed by the Branch Manager, the Plant Manager, the Maintenance man, and the employee submitting the form. The primary purpose of the Hazard Review is to first identify whether the hazard does in fact exist and if so, what can and should be done to eliminate the hazard. If the hazard identified is an unsafe condition, the review should focus on what can and should be done to eliminate the hazard.

8.2.1.3 Elimination of Hazards

Based on the findings and recommendations made during this review process, a definitive course of corrective action will be identified and recorded on the facility's Corrective Action Log after which the required corrective action will be performed.

8.2.2 Accident Investigation and Review

The purpose of an accident investigation and review is to gather information concerning an accident so that the cause of the accident may be identified. It is <u>NOT</u> the intent of the accident review to place the blame. The accident investigation and review can be broken down into three steps: 1) Accident Investigation, 2) Implementation of Recommendations, and 3) Monitor.

8.2.2.1 Accident Investigation

All employees have been instructed to and are required to report any incidents including accidents to their supervisor as soon as possible and no later than the end of the shift on which it occurs. Employees involved in an incident/accident will participate in the investigation, at least to the extent of contributing to a witness statement.

The accident investigation will follow the format outlined on the JCI Accident Investigation Report. The investigation must be started within forty-eight (48) hours of the incident, and the written report must be completed as soon as possible thereafter.

The Branch Manager and/or his/her designee is responsible for conducting the accident investigation, and will determine which employees will assist with the investigation. When conditions warrant, the JCI corporate office personnel will join in the investigation. Once the investigation is completed and it has been determined exactly what factors caused the accident, an Accident Investigation Report must be completed that includes a "Description" section that thoroughly documents exactly what took place following a step by step process from beginning to end, an "Analysis" section that thoroughly documents all of the contributing factors such as people, equipment, material and or the environment that went into the process of determining what the exact cause(s) of the accident were, and a "Prevention" section that thoroughly documents the measures to be taken to prevent a reoccurrence. The Accident Investigation Report is then reviewed by a member of the JCI corporate office prior to any corrective action being taken.

8.2.2.2 Implementation of Recommendations

Once the investigation has been completed and recommendations for corrective action have been identified and agreed upon, the Branch Manager assigns responsibility for implementation of the recommendations.

8.2.2.3 Monitor

The Branch Manager then ensures the implementation and effectiveness of the recommendations by monitoring the actions.

8.3 Site Inspections

This section summarizes the self-inspection and review process that has been implemented.

8.3.1 Daily

Rounds of the plant are conducted continually by operators, supervisors, and the Branch Manager. The purpose of these rounds is to perform a cursory visual inspection of each system for indications of malfunction. Readings on the pressure, temperature, flow indicators, etc., are discussed with fill station operators at this time to ensure that they are operating properly.

8.3.2 Weekly

The Branch Manager or a designated employee must inspect the site weekly and prepare a written report. The process is detailed in the Environmental Manual, Chapter XXII.

8.3.3 Monthly

An Environmental Report is submitted monthly. It is a checklist report to be sure required inspections and reports have been done. The report is contained in the Environmental Manual, Chapter XXII.

Each facility must conduct a thorough safety and security equipment inspection at the facility each month and submit a written report. The requirements for this report are contained in the Safety Manual, Chapter V. Certain safety equipment such as safety showers and emergency eye wash stations are inspected on a weekly basis to ensure proper operation.

8.3.4 Periodic

Whenever a facility wants to add a product or change an existing product a written New Product Checklists must be submitted for review and approval. The requirements for this report are contained in the Environmental Manual, Chapter XXVI.

8.3.5 Corporate Staff

The JCI corporate staff reviews the documents as submitted. Members of the JCI corporate staff also conduct both announced and unannounced on-site reviews of various disciplines.

8.4 Periodic Physicals

Periodic physicals (i.e., annual or biannual), are available for designated employees dependent on specific job functions and responsibilities (i.e., emergency response team members and drivers).

8.5 Other

To the extent allowed by law, the company requires pre-employment drug screening and random drug testing after employment.

SECTION 9
TRAINING

9.0 Training

Employee training is a prime requisite for safe operations and an effective release prevention program. A formal program has been established to facilitate training. This program consists of:

- A Safety Manual that discusses and explains policies and procedures;
- A Safety Training Manual that provides details on the various training and instructional programs that have been established for all employees;
- Monthly safety training meetings;
- Safety awareness displays and bulletin board postings;
- Safety department communications;
- Safety videos and DVDs;
- Written employee training records;
- Accident information;
- Drills; and
- Other resources.

Other avenues of communication have been developed that review current injury statistics and discusses trends that exist, as well as setting the direction for the facility.

9.1 Overview

Ongoing communication of health and safety matters ensures that all personnel are properly trained. All facility personnel, including office and sales personnel, drivers, and plant employees, receive training. JCI's safety training program is based on a three-year cycle however depending upon the topic the training may be conducted more frequently such as annually. All training is documented on each employee's Record of Training (JCI Safety Training Manual, Chapter I).

The primary employee training program can be broken down into three phases:

1. New Employee Indoctrination;
2. Job Instruction Training; and
3. Periodic Training.

A description of the primary employee training programs provided by JCI under each of these three phases is provided below.

9.1.1 New Employee Indoctrination

Training for new employees is a combination of classroom and activity-specific on-the-job training. Training is completed when the new employee demonstrates competency in the new job to the Branch Manager, Plant Manager, and Foreman.

New employee indoctrination is the orientation of a new employee to the JCI Corporate Health and Safety policies and procedures, before they begin work. ALL new employees are trained in the following, including but not limited to the following:

- General and Plant Safety Rules
- Hazard Communication Program
- Personal Protective Equipment
- Contingency Plan and Plant Evacuation Plan
- Accident Prevention and Injury Reporting
- Hazard Reporting Procedures
- Smoking Policy

- Material Handling Procedures
- Operation of Emergency Eyewash & Safety Shower
- First Aid Procedures
- Back Injury Prevention
- Lockout/Tagout Program Awareness
- General Security Awareness

A safety training form is signed and dated by the new employee to indicate that specific topics have been covered and understood. The new employee then goes through respiratory protection training and is fitted for a respirator (if required by his or her job duties). Lastly, the new employee is supplied with personal protective equipment including approved safety glasses or goggles, bump cap (optional), and an escape respirator. Safety shoes are also required.

9.1.2 Job Instruction Training

Given the products manufactured and repackaged by JCI Jones Chemicals, Inc., all employees, and particularly plant employees and drivers, receive on-the-job training on specific tasks that an employee will be expected to perform once released to do the job on his or her own. Job Instruction Training is the process followed in providing on-the-job training pertaining to specific tasks for new employees, transferred employees, and experienced employees alike as it accomplishes the following:

- Provides the most effective means for helping new employees learn to perform their jobs both safely and efficiently
- Ensures that consistency in operations is maintained
- Shortens the learning curve
- Serves to provide hands on training under close supervision so as to minimize the likelihood of injuries, accidents, spills, leaks, and or releases.

During job instruction, both the job and the associated performance standards that must be met are explained in detail to the employee being trained. Next, the trainer performs the job functions along with the employee being trained. This enables the trainee to see the work being performed exactly as they will do it on the job. The last step is to allow the trainee to perform the job in a trial performance. At this point in the instruction cycle, the trainer becomes a coach and watches the trainee perform. This is continued until the trainee has mastered the job.

Of particular importance in conducting on-the-job training are the safety and health hazards associated with the job, and emergency operations, to include emergency shutdown procedures, applicable to the employee's job tasks.

9.1.3 Periodic Refresher Training

In addition to safety training received as a new hire, all employees are required to attend periodic refresher safety training meetings relative to their job position. The purpose of periodic refresher safety training is to update employees on changes in processes, training information, regulations, etc. and to reinforce the safety training an employee has previously received as well as the proper method to perform a specific job. This training is necessary when an employee returns to a job he/she previously learned, employee performance needs to be improved, a new product is handled at the plant, or new equipment or processes are installed. Periodic refresher safety training is also provided when an employee is assigned to a different job or requires additional training in his/her present job. The training required depends on the employee's job position.

9.2 Equipment Operations and Maintenance Training

All plant operators and maintenance personnel are trained in the general procedures for operation and maintenance of all plant equipment. In addition, each employee receives further specialized training in their specific job responsibilities. Each employee is required to undergo a training program for each piece of equipment or system that he/she is responsible for operating or maintaining. Training is conducted by the Branch Manager or his/her designee on plant standard operating procedures (SOPs) and specific equipment operating or maintenance procedures. Employees go through job instruction training under the supervision of the Branch Manager or his/her designee. For each of the equipment training programs, the employee must show proficiency in a number of items through any and all performance testing before he is allowed to operate or perform maintenance on a particular piece of equipment. Once an employee has completed the proficiency testing and training requirements for the tasks of a specific job operation, the trainer observes the employee performing the tasks. If the employee performs to his satisfaction, the trainer signs off on the training record and transfers it to the employee's personnel file.

9.3 Emergency Response Training

All members of the facility’s Emergency Response Team have gone through an initial 24-hour emergency response training class. The initial training course includes instruction in operation of all fire protection and fire-fighting equipment, release control and containment procedures, personal protective clothing, plant and agency emergency notification procedures, and evacuation procedures. In addition, all employees have been familiarized with the facility’s Contingency Plan. All members of the facility’s Emergency Response Team are required to complete an 8-hour annual refresher course on emergency response training and will be tested on their knowledge and understanding of the facility’s Contingency Plan. It is recommended that emergency response training drills be held on a periodic basis to maintain proficiency. Following the drill, a meeting will be held to critique the emergency response procedures performed during the drill and to identify any portions of the drill or other topics and procedures that should be modified in light of the information obtained during the drill.

Employees may be asked to perform accident rescue operations using self-contained breathing apparatus (SCBA) and other personal protective equipment. The purpose of these drills is to continually reduce rescue times and familiarize employees with use of the self-contained breathing apparatus.

9.4 Environmental Compliance, Reporting and Record Keeping Procedure Training

All plant personnel receive instruction on regulatory compliance requirements. Personnel will be instructed in their respective responsibilities for waste water discharge and monitoring, proper hazardous waste disposal requirements and record keeping procedures, and required regulatory agency reports for hazardous substance spills and releases, and waste water discharges and monitoring. Personnel will also be instructed on proper filing and documentation procedures for all regulatory related correspondence, reports, and permits.

SECTION 10
EMERGENCY RESPONSE

10.0 Emergency Response

The facility has a trained emergency response team, and appropriate equipment and supplies. The equipment includes a recovery vessel ("coffin") to contain a leaking 150-pound chlorine or sulfur dioxide cylinder, and Chlorine Institute approved A-Kits, B-Kits, and C-Kits to contain a leaking 150-pound, 2000-pound or 90-ton container respectively of chlorine or sulfur dioxide.

10.1 Facility Emergency Response Plan

The facility has a detailed Contingency Plan based on corporate guidelines and facility specific information. The Contingency Plan outlines the procedures to be taken in the event of an accidental release of either liquids or gases and specifies notification, evacuation, and release control and containment measures for accidental releases that may occur at the plant or on the highway (in transportation accidents). Review of the plan is conducted at the facility's monthly safety meetings. The Branch Manager is responsible for updating the Contingency Plan.

The Contingency Plan provides a listing of all employees and their respective job descriptions. A primary emergency coordinator and an alternate coordinator are designated in the plan. A minimum of four (4) employees are designated emergency responders. The home telephone numbers and addresses of the primary and alternate coordinators are also included. The emergency coordinator is in charge during release incidents and is given the authority to commit the resources necessary to implement the plan. The emergency coordinator is responsible for warning all plant employees of the emergency, coordinating facility procedures, and communicating with local response teams.

10.2 Emergency Response Exercises and Simulations

It is recommended that facility personnel conduct periodic emergency response training exercises each year. These exercises are discussed at the monthly safety training meetings and the critiques are used to update the Contingency Plan if necessary.

10.3 Fire, Evacuation, and Rescue Corridors

A primary staging area, a secondary staging area, and evacuation routes are designated in the plan. Personnel without assigned duties and personnel that have fulfilled their emergency response duties assemble at the primary staging area. In the event the primary staging area is determined to be unsafe, the secondary staging area is used. When both areas are deemed unsafe, the emergency coordinator designates an area for personnel to assemble.

The facility has established evacuation procedures as outlined in the Contingency Plan. The corridors leading to the exits are kept free of obstructions. During evacuation, personnel meet at the designated staging area. An employee is designated to muster personnel in the Contingency Plan and is responsible for ensuring that all employees, visitors, and contractors on-site are accounted for.

10.4 Emergency Equipment Provisions

The facility maintains the majority of its emergency response equipment in the breezeway main entrance to the plant. There are 5 self-contained breathing apparatuses (SCBAs), 9 fully encapsulating suits, 2 Chlorine Institute "A" kits for cylinders, 2 Chlorine Institute "B" kits for ton containers, 3 Chlorine Institute "C" kit for tank cars, and 1 chlorine recovery vessel.

Caustic soda and soda ash are stored in the warehouse to absorb and or neutralize spills. In addition, hand held fire extinguishers are located throughout the facility.

Fire extinguishers, gas masks, eyewash, and shower stations are located throughout the facility. Employees are required to wear safety glasses, bump caps (optional), and steel-toe shoes, and carry escape respirators.

All safety equipment is inspected monthly.

10.5 Emergency Response Chain of Authority

The designated emergency coordinator is in charge during emergency situations. Authority is relinquished to the local fire department upon their arrival. The emergency coordinator assists the response effort as requested.

10.6 Emergency Response Management Procedures

The emergency coordinator position is held by a member of facility management. The emergency coordinator is responsible for all actions taken to mitigate an emergency until local response agencies arrive.

10.7 Emergency Communication Notification Within the Facility

See Section 6 – Detection and Monitoring, and the facility's Contingency Plan.

10.8 Emergency Response Personnel Training Requirements

Facility emergency response personnel receive at least 24 hours of initial, in-house emergency response training, as well as at least 8 hours of annual refresher training.

10.9 Follow-up Release Procedures

In most release cases, assigned facility personnel do the clean-up activities. The JCI Corporate Office may also employ an outside environmental cleanup agency for use in the cleanup of a major release should one occur. Following a release, a full plant, in-house critique is performed.

10.10 Previous Incidents Involving HHC

The five-year accident history for this facility is contained in the facility's Risk Management Plan Manual.

SECTION 11
PROCESS HAZARD ANALYSIS

11.0 Introduction

This section documents the results of the Process Hazard Analysis (PHA) for the JCI facility located at 40 Railroad Avenue, Merrimack, New Hampshire.

On February 19, 2014, a Process Hazard Analysis (PHA) meeting was held at the JCI facility located at 40 Railroad Avenue, Merrimack, New Hampshire (“the facility”). Present were:

Tim Gaffney	Executive V.P. Environmental Affairs & Risk Management
Dan Casmey	Executive V.P. Safety, Security & Regulatory Compliance
Frank Levin	Interim Branch Manager
Roger Costain	Plant Manager
Joe Devereaux	Plant Foreman
Lailani Metzler	Senior Consultant, Arcadis U.S., LLP

The PHA meeting included a brief overview of the PHA technique to be used. The “What If” technique was chosen based on the past PHA and PHA sessions at other JCI facilities. A brief facility tour was conducted to verify the generic process flow diagram (including all flow control valves and pressure gauges) for each handling system. Informal discussions with several plant operators regarding operating procedures, emergency response procedures, facility evacuation plan, emergency staging areas, alternate staging areas, and general level of experience at the facility were also held. A facilitated discussion in the facility’s conference room followed the tour.

11.1 – Background

11.1.1 - Description of the "What If?" Process Hazard Analysis Technique

The concept of a "What If?" analysis is to conduct a thorough and systematic examination of the process or operation under review by asking questions that begin with "What If?". The examination can include buildings, power systems, raw materials, products, storage, materials handling, in-plant environment, operating procedures, work practices, management practices, plant security, and other pertinent parts of plant operations. While in the process of conducting the “What If?” analysis, it is important to consider the “human factors” associated with each process, event, and/or function being reviewed and specifically the relationship between our employees and each process event and/or function. The formulation of the exact questions is left up to those individuals conducting the process hazard analysis, unless questions have been formulated during a previous process hazard analysis. The intent of this analysis is to reduce any potential risks identified if possible by modifying either operating procedures and/or equipment.

The questioning usually starts at the input to the process and follows the flow of the process to the output. Alternatively, the questioning can center on a particular consequence category (e.g., personnel safety, public safety, etc.). A team comprised of personnel experienced with the operation of the regulated processes and a facilitator experienced with the PHA process conducts the examination and reports the findings. In general, the findings consist of accident event sequences that result from the "What If?" questions. The questions essentially suggest an initiating event, and perhaps a failure from which an undesirable event sequence could occur. For example, a typical "What If?" question might be: "What if the raw material is the wrong concentration?"

The process hazard analysis team would then attempt to determine how the process being evaluated would respond.

11.1.1.1 - Guidelines for Using the "What If?" Process Hazard Analysis Technique

The "What If" process hazard analysis technique includes the following steps:

Define the study boundaries.
Gather the needed information.
Define the process hazard analysis team.
Conduct the process hazard analysis (process review).
Develop recommendations.
Record the results.

11.1.1.2 - Define the Study Boundaries

There are two types of study boundaries in a "What If?" study: the physical system boundaries and the consequence category being evaluated. These two boundaries are closely related. That is, the consequences to be evaluated will define what portions of the plant to consider in the evaluation (process hazard analysis). Thus, it is important that the consequences category be defined first, with the consequence category being defined as risk or safety if a substance of concern is released.

After the consequence category has been defined, the physical boundaries of the study can be defined. The purpose of defining the physical boundaries of the process hazard analysis is to keep the process hazard analysis team focused on portions of the facility in which the consequence of concern could occur. Care must be taken in defining these boundaries because very often there are interactions between parts of a plant, some of which may not be hazardous in and of themselves (relative to the consequence being considered) but which may cause some other portion of the plant to perform abnormally and hence result in an accident event sequence.

The physical boundaries of the "What If?" analyses were defined as each of the sources of chemicals of concern within the boundaries of the facility. Thus, each "system" was defined as all steps/activities involving a highly hazardous chemical from the point at which it is received at the facility to the point at which repackaged containers containing that chemical is loaded onto delivery trucks and shipped off-site.

11.1.1.3 - Gather the Needed Information

It is important that all critical information be available to the team during the process hazard analysis to allow the evaluation process to continue unhindered. Therefore, after the study boundaries have been defined, information needed to perform the process hazard analysis is gathered and reviewed. For JCI, the information included the following:

- Facility site layout and plot plan and regional topographic map;
- Standard operating procedures including those for the chemicals to be studied which are contained in the Production

Manual;

- Standard maintenance procedures, preventive maintenance procedures, and inspection procedures which are contained in the Mechanical Integrity Manual;
- Site inspection policy and procedures which are contained in the Environmental Manual;
- Operator training procedures which are contained in the Safety Training Manual;
- Health and safety procedures and OSHA process safety management compliance program which are contained in the Safety Manual and Safety Training Manual;
- OSHA hazard communication program which is contained in the Safety Training Manual;
- Emergency response procedures contained in the facility Contingency Plan Manual, Safety Manual, Safety Training Manual, and Environmental Manual.
- Facility equipment and specifications which are contained in the facility’s Process Safety Information section of their PSM files;
- Site security plan contained in the Security Manual;
- Facility transportation which is contained in the Transportation Manual and the Environmental Manual.

This information was then evaluated and utilized to formulate a preliminary listing of "What If?" questions to be addressed during the process hazard analysis.

11.2 - Process Hazard Analysis

The HHCs handled at the facility are chlorine (Cl_2) and sulfur dioxide (SO_2). Sodium hypochlorite and sodium bisulfite are also handled at this facility but these chemicals are not listed under the Occupational Safety and Health Administration (OSHA) Process Safety Management (PSM) standard. However, because the HHCs are used as raw materials for the production of sodium hypochlorite and sodium bisulfite at the facility, JCI conducted a PHA for these processes.

Chlorine is brought on site in bulk quantities and repackaged into smaller containers for distribution to customers. Sulfur dioxide is brought on site already repackaged in smaller containers ready for distribution to customers. In addition, chlorine is used in the manufacture of sodium hypochlorite (bleach) and sulfur dioxide is used to make sodium bisulfite. Products are subsequently packaged and distributed to customers by truck.

The HHC's, respective Threshold Quantity, and Maximum Intended Inventory at this facility are listed in the table below.

HHC	Threshold Quantity	Maximum Intended Inventory
Chlorine	1,500 pounds	975,000 pounds
Sulfur dioxide	1,000 pounds	51,600 pounds

In general, the amount of a particular HHC present on site at any specific time will exceed its respective TQ.

A “What If?" analysis technique for process hazard analysis was selected because of the “non-complex" nature of operations involving the HHC's handled at the JCI facility and because this PHA technique has been successfully applied to evaluate the HHC processes at the facility in the past.

The "What If?" questions for the HHC's and their respective processes at this facility are listed below.

11.2.1 – Chlorine Process

11.2.1.1 – Chlorine Repackaging

What If?

- Rail car has a transportation accident with facility traffic or visiting vehicles (e.g. forklifts, tractors, tank trucks, cars, etc.).
- Rail car has a transportation accident with another rail car on the spur during docking or spotting.
- A rail car is delivered with or develops a liquid phase pinhole leak.
- A rail car is delivered with or develops a vapor phase pinhole leak.
- Rail car develops a slow leak in liquid phase due to an external event.

- Rail car develops a slow leak in vapor phase due to an external event.
- Railcar has a catastrophic failure.
- The wrong rail car is connected to the system.
- Rail car is over pressurized.
- Failure of main rail car valve.
- Failure of transfer piping or transfer piping valves at various points in the system.
- Any of the components of the railcar unloading system such as the ammonia flanges and or bolts fail while the system is connected and charged.
- Liquid chlorine is trapped in either the body of valves and or short sections of piping such as railcar nipples and or whips when the shutdown system is activated.
- System barometric loop, to include fittings, fails.
- Filling station valve(s) fail.
- Filling station liquid blow down lines/vacuum lines or blow down ton containers fail or overfill.
- Filling station operator fills wrong container.
- There is water/moisture in the container prior to filling.
- Filling station operator overfills container.
- Catastrophic failure of one-ton container.
- Catastrophic failure of 150-pound cylinder.
- A 150-pound cylinder begins leaking any time during the filling process, during the disconnection process, or immediately after the disconnection process (i.e., a pin hole leak from the body of the container, a leak from a cross threaded packing nut, a leak past the valve stem and through the packing nut, leak from whip during the disconnection process, or a leak from anywhere on the container to include the valve after being disconnected).
- A one-ton container begins leaking any time during the filling process, during the disconnection process, or immediately after the disconnection process (i.e., a pin hole leak from the body of the container, a leak from a cross threaded packing nut, a leak past the valve stem and through the packing nut, leak from whip during the disconnection process, or a leak from anywhere on the container to include the valve after being disconnected).
- Filling station operator is filling containers during inclement weather (e.g., rain, high winds, etc.).

- Accident during storage or transfer of filled containers resulting in the container valve being “knocked off”.
- Fire in storage area or near fill stations.
- Water in chlorine air pad system.
- Disgruntled employee commits sabotage.
- Vacuum system failure.
- Mitigation system failure.
- Sensor failure.
- Spare sensor parts are not available.
- Sensor is improperly set.
- CL2 lines are not properly identified.
- Eye wash station is not available.
- Improper tools are used in the processing of chlorine containers (i.e., filling, changing valves and fuse plugs, etc.).
- CL2 alarm sounds and there is no leak.
- Emergency response equipment is not properly stored outside of the expected release areas (i.e., in a “safe/cold zone”).
- Local emergency response agencies (i.e., Fire Department, Police Department, etc.) are unfamiliar with facility operations to include the products handled and their associated hazards.
- Systems are not inspected regularly.
- PPE fails.
- Pipe hangers fail.
- There is a lack of or failure of controls on employees in the workplace.
- Changes in technology, equipment, and or procedures are not communicated to employees.
- Changes in system status are not communicated between employees when employees change tasks (i.e., if an employee begins a task, is called away, and returns after another employee has stepped in and performed part or all of the task originally being performed by the first employee), and or a shift change takes place.
- Employee attempts to disconnect a cylinder or ton container that has been blown down without first closing the blow valve and opening the vacuum valve.
- Employee attempts to remove a valve on a cylinder or ton container that has not been properly blown down and vacuumed.

- There is a power failure.
- The rupture disc in an expansion chamber ruptures.
- A whip on a ton or cylinder ruptures while the container is being filled and before the container is completely filled.
- A leak develops at a railcar while the railcar is being connected.
- A leak develops at a railcar while the railcar is being disconnected.
- The wrong whip is used either at the filling stations or at the railcar.
- Chlorine ton containers or cylinders are not completely blown down and vacuumed prior to refilling them.

11.2.1.2 – Chlorine Storage and Distribution

What If?

- Facility traffic, visiting vehicle or delivery vehicle (e.g. forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with a chlorine railcar.
- Facility traffic, visiting vehicle or delivery vehicle (e.g. forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with stored chlorine ton containers or cylinders.
- Facility traffic, visiting vehicle or delivery vehicle (e.g. forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with the chlorine transfer piping system.
- A ton container or cylinder in storage develops a leak in either the liquid or vapor phase (either during working or non-working hours to include over the weekend).
- A "residue last contained" ton container or cylinder is received back at the facility and subsequently develops a leak in either the liquid or vapor phase prior to the container being processed (either during working or non-working hours to include over the weekend).
- Catastrophic failure of a one-ton container.
- Catastrophic failure of a 150-pound cylinder.
- A ton container or cylinder develops a slow leak in the liquid or vapor phase due to an external event.

- A ton container develops a catastrophic leak in the liquid or vapor phase due to an external event.
- A cylinder develops a catastrophic leak in the liquid or vapor phase due to an external event.
- Accident during storage or transfer of filled containers resulting in the container valve being "knocked off".
- Ton container or cylinder falls off either the forklift or the trailer during the loading or unloading process.
- Fire in storage area.
- Disgruntled employee commits sabotage.
- Chlorine ton containers or cylinders are stored in close proximity to incompatible materials and develop a leak.
- There is a lack of or failure of controls on employees in the workplace.

11.2.2 – Sulfur Dioxide Process

11.2.2.1 – Sulfur Dioxide Storage and Distribution

What If?

- Facility traffic, visiting vehicle or delivery vehicle (e.g. forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with a sulfur dioxide railcar.
- Facility traffic, visiting vehicle or delivery vehicle (e.g. forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with stored sulfur dioxide ton containers or cylinders.
- Facility traffic, visiting vehicle or delivery vehicle (e.g. forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with the sulfur dioxide transfer piping system.
- A ton container or cylinder in storage develops a leak in either the liquid or vapor phase (either during working or non-working hours to include over the weekend).
- A “residue last contained” ton container or cylinder is received back at the facility and subsequently develops a leak in either the liquid or vapor phase prior to the container being processed (either during working or non-working hours to include over the weekend).
- Catastrophic failure of a one-ton container.

- Catastrophic failure of a 150-pound cylinder.
- A ton container or cylinder develops a slow leak in the liquid or vapor phase due to an external event.
- A ton container develops a catastrophic leak in the liquid or vapor phase due to an external event.
- A cylinder develops a catastrophic leak in the liquid or vapor phase due to an external event.
- Accident during storage or transfer of filled containers resulting in the container valve being "knocked off".
- Ton container or cylinder falls off either the forklift or the trailer during the loading or unloading process.
- Fire in storage area.
- Disgruntled employee commits sabotage.
- Sulfur dioxide ton containers or cylinders are stored in close proximity to incompatible materials and develop a leak.
- There is a lack of or failure of controls on employees in the workplace.

11.2.3 – Sodium Hypochlorite Manufacturing Process

11.2.3.1 – Bleach Machine

What If?

- There is a leak from the chlorine supply piping.
- The bleach machine recycle tank is over-chlorinated.
- There is low caustic concentration in the bleach machine.
- Sodium hypochlorite leaks from bleach machine, transfer lines, or storage tanks and mixes with incompatible materials.
- The flow or circulation of the caustic soda solution is interrupted during chlorination.
- The pipes or vessels overheat.
- The system over-pressurizes.
- There is a power failure.
- Human error occurs (i.e., manual valves throughout the bleach manufacturing system are not opened, set points for the strength of the solution are not properly programmed, the appropriate circulation system valves are not opened, etc.).
- There is a low level event in the recycle tank.
- The solenoid to open the valve for the dilute caustic soda solution that reacts with the chlorine in the recycle tank

malfunctions stopping the flow of caustic soda to the recycle tank.

- The vacuum breaker on the bleach recycle tank remains stuck in the open position.
- There is a lack of or failure of controls on employees in the workplace.

11.2.3.2 – Make Vats/Blow Gas

- There is a leak from the chlorine supply piping.
- The sodium hypochlorite make vats are over-chlorinated.
- There is a low-level event in the sodium hypochlorite make vats that exposes the chlorine supply pipe.
- The flow or circulation of the caustic soda solution is interrupted during chlorination.
- Sodium hypochlorite leaks from the make vats, transfer lines, or storage tanks and mixes with incompatible materials.
- The pipes or vessels overheat.
- The system over-pressurizes.
- There is a power failure.
- Human error occurs (i.e., manual valves throughout the bleach manufacturing system are not opened, the appropriate circulation system valves are not opened, etc.).
- There is a lack of or failure of controls on employees in the workplace.

11.2.4 – Sodium Bisulfite Manufacturing Process

11.2.4.1 – Make Vats/Blow Gas

- There is a leak from the sulfur dioxide supply piping.
- The sodium bisulfite make vats are over-sulfonated.
- There is a low-level event in the sodium bisulfite make vats that exposes the sulfur dioxide pipe.
- The flow or circulation of the caustic soda solution is interrupted during sulfonation.
- Sodium bisulfite leaks from the make vats, transfer lines, or storage tanks and mixes with incompatible materials.
- The pipes or vessels overheat.
- The system over-pressurizes.
- There is a power failure.
- Human error occurs (i.e., manual valves throughout the sodium

bisulfite manufacturing system are not opened, the appropriate circulation system valves are not opened, etc.).

- There is a lack of or failure of controls on employees in the workplace.

11.2.5 - Developing Scenarios

The questions listed above were entered on a form and numbered. Responses to the "What If?" questions, consequences, safeguards, and recommendations were developed. Each "What If?" question, its consequences, safeguards and recommendations are a scenario. Each scenario is identified by a numeric notation corresponding to the question number. This allows tracking of each scenario recommendation. It also allows ranking and screening by a matrix to achieve qualitative analysis based on likelihood of occurrence and severity. The results are contained in Section 12.

SECTION 12
RESULTS OF THE WHAT IF HAZARDS ANALYSIS

12.0 Results

The following tables contain the results of the "What If?" process hazard analysis for the HHCs at the facility.

TABLE 12.1 - Results of the "What If?" Process Hazard Analysis for the Chlorine Repackaging System

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
1. Rail car has a transportation accident with facility or visiting traffic (e.g., forklifts, tractors, tank trucks, cars, etc.).	There could be a release of anywhere from less than one-pound to 90-tons of chlorine. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• This scenario is extremely unlikely since rail car docking area is off limits to facility traffic. • Rail cars rarely cross the roadway coming into the site. • In addition, there is a 5-MPH speed limit for facility traffic. • There is also fencing around all of the railcars.	None.	3A
2. Rail car has a transportation accident with another rail car on the spur during docking or spotting.	There could be a release of anywhere from less than one-pound to 90-tons of chlorine. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• Procedures are in place between JCI and the railroad performing the switch to prevent this scenario, and it is extremely unlikely.	None.	3A
3. A rail car is delivered with or develops a liquid phase pinhole leak.	There could be a minor release.	• JCI personnel would expedite unloading of the rail car into ton containers. • C-Kits are maintained onsite that can be used to stop a leak. • However, this scenario would be extremely unlikely as all rail cars are regulated by the DOT and are inspected regularly.	None.	2A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
4. A rail car is delivered with or develops a vapor phase pinhole leak.	See Item 3 above.	• See Item 3 above.	None.	1A
5. Rail car develops a slow leak in liquid phase due to an external event.	Depending on the size of the leak the release could be significant, but most likely not the entire contents of the railcar. Under a major or catastrophic release the Jones Chemicals Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911.	• JCI's Gas Detection System would provide JCI personnel with immediate notification of the release. • The automatic railcar valve closure system would then be activated. • C-Kits are maintained onsite that would be used to stop the release.	None.	2A
6. Rail car develops a slow leak in vapor phase due to an external event.	See Item 5 above.	• See Item 5 above.	None.	1A
7. Rail car has a catastrophic failure.	There could be a release of up to 90 tons of chlorine. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911 and the facility Emergency Response Coordinator would initiate plant evacuation.	• JCI's Gas Detection System would provide JCI personnel with immediate notification of the release. • The automatic railcar valve closure system would then be activated. • CHLOREP response procedures would then be initiated.	None.	3A
8. The wrong rail car is connected to the system.	Not applicable since the only compressed gas railcars handled by this facility is chlorine.	• Not applicable since the only compressed gas railcars handled by this facility is chlorine.	None.	1A
9. Rail car is over pressurized.	The pressure relief valve on the railcar would rupture releasing chlorine vapor before reseating.	• The compressor has a maximum pressure of approximately 180 psi. • The railcar has a relief valve with a set point of 350 psi.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
10. Failure of main rail car valve.	There could be unrestricted flow of chlorine up to 90 tons. If the excess flow valve failed, there could be unrestricted flow of chlorine again up to 90 tons. If the leak was minor, personnel would don personal protective equipment and attempt to mitigate the release by applying a C-kit to the valve. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• Each car has an excess flow valve (ball valve) between the main valve and the contents of the car. • The valve would automatically stop flow. • The valve is never opened without being connected to a closed system.	None.	3A
11. Failure of transfer piping or transfer piping valves at various points in the system.	There would be a release of chlorine up to the amount in the piping between the actuated valves on each side of the failure point.	• The potential for leaks due to corrosion in the transfer piping or transfer piping valves is limited since the corrosion rate is slow for dry chlorine and the system undergoes an annual inspection. • The dew point monitor is checked daily to ensure that only dry air is being used to pad the railcars. • Redundant actuated valves in the transfer piping system reduce the amount of product that could be released as a result of a failure anywhere in the transfer system.	None.	2A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
12. Any of the components of the railcar unloading system such as the ammonia flanges and or bolts fail while the system is connected and charged.	It is not impossible that liquid chlorine could escape due to a flange failure, regardless of the cause, however, given that the unloading system is equipped both with actuated valves and a railcar valve closure system linked to gas detection sensors, at worst case, the maximum quantity of chlorine that would or could be released is 2.7456 lbs based on a whip 6' long with an inside diameter of 0.957". It is unlikely that this could be considered to represent a situation that could result in catastrophic consequences.	• Visually checking the condition and operation of all components of the railcar unloading system; i.e., the valves, airline, flanges, whip(s), and piping, prior to fully charging the system with liquid chlorine, is part of established startup procedures.	None.	1A
13. Liquid chlorine is trapped in either the body of valves and or short sections of piping such as railcar nipples and or whips when the shutdown system is activated.	The consequences are relatively insignificant. Based on the fact that the piping and associated fittings are industry standard (i.e., 1,500 lbs and 3,000 lbs carbon steel respectively), and are specifically designed for chlorine service, trapping 0.038 lbs per inch in 1" piping and or 0.0229 lbs per inch in ¾" piping is not considered to be potentially problematic anywhere in a system that is not protected by an expansion chamber. With respect to valve bodies, the valves in use are specifically designed to vent excess cavity pressure, thereby ensuring that liquid chlorine is not and cannot be 'trapped' in the body of the valve.	• The entire transfer system is blown down and a vacuum is applied before the shutdown system is activated.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
14. System barometric loop, to include fittings, fails.	This may result in the release of a minor amount of chlorine gas.	• The barometric loop is designed to prevent back flow of liquid into the system. • A failure of the loop would result in the breakage of the line and therefore no back flow could conceivably occur.	None.	1A
15. Filling station valve(s) fails.	A minor release of chlorine could occur.	• Leak detectors located throughout the process area would trigger an automatic shutdown. • Manual shutdown buttons (E-Stops) and audible alarms are also positioned throughout the process area.	None.	1A
16. Filling station liquid blow down lines/vacuum lines or blow down ton containers fail or overfill.	Normally there is a very small amount of chlorine in the vacuum or blow down container. Failure could result in the release of the entire contents of the blow down container. If additional chlorine is added, the excess will flow into the bleach vats eventually triggering the ORP alarm. In the case of overfilling, a problem will occur only if the discharge valve on the surge ton is closed, thereby preventing the transfer of chlorine to the blow vat(s).	• Alarm will activate if vacuum fails.	None.	2A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
17. Filling station operator fills wrong container.	The container would be filled with the wrong gas and would have to be emptied. No release would be expected.	• This scenario is highly unlikely because the cylinders are differentiated by color coding and are stenciled. • In addition, supervisors are constantly overseeing the operations. • There are designated locations for storage of filled containers, empty containers, and those that have been detailed. • These areas are clearly marked and boundaries delineated.	None.	1A
18. There is water/moisture in the container prior to filling.	Excessive heat could build up over time in the container eventually resulting in the fuse plug(s) melting and the subsequent release of product.	• This scenario is highly unlikely because all containers are emptied, a vacuum pulled, a cylinder valve or ton container fuse plug removed, the interior inspected, and the valve or fuse plug replaced before the container arrives at the filling station. • In addition, supervisors are constantly overseeing the operations. • There are designated locations for storage of filled containers, empty containers, and those that have been detailed. • These areas are clearly marked and boundaries delineated.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
19. Filling station operator overfills container.	Minor overfilling is possible.	• All ton and cylinder scales are equipped with automatic shutoffs that are activated when the target fill weight is reached. • In addition, operators are always in attendance while the container is being filled.	None.	1A
20. Catastrophic failure of one-ton container.	A catastrophic failure of a one-ton container would result in the release of up to one-ton of chlorine.	• All containers undergo thorough hydrostatic testing and other preventive maintenance procedures.	None.	3A
21. Catastrophic failure of a 150-pound cylinder.	A catastrophic failure of a 150-pounnd cylinder would result in the release of up to 150 pounds of chlorine.	• All containers undergo thorough hydrostatic testing and other preventive maintenance procedures.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
22. A 150-pound cylinder begins leaking any time during the filling process, during the disconnection process, or immediately after the disconnection process (i.e., a pin hole leak from the body of the container, a leak from a cross threaded packing nut, a leak past the valve stem and through the packing nut, leak from whip during the disconnection process, or a leak from anywhere on the container to include the valve after being disconnected).	A release of up to 150 pounds of chlorine could occur. The filling system would be shut off and appropriate response actions would be taken, i.e., by evacuating the contents of the container, installing an A-Kit, or placing the container in a recovery vessel.	• Cylinders are visually inspected both internally and externally prior to being filled. • In addition, cylinders are hydrostatically tested every 5 years in accordance with DOT regulation. • Valve bodies and internal components are visually inspected prior to the container being filled. • Leak detectors located throughout the process area would trigger an automatic shutdown. • Manual shutdown buttons (E-Stops) and audible alarms are also positioned throughout the process area.	None.	2B

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
23. A one-ton container begins leaking any time during the filling process, during the disconnection process, or immediately after the disconnection process (i.e., a pin hole leak from the body of the container, a leak from a cross threaded packing nut, a leak past the valve stem and through the packing nut, leak from whip during the disconnection process, or a leak from anywhere on the container to include the valve after being disconnected).	A release of up to 2000 pounds of chlorine could occur. The filling system would be shut off and appropriate response actions would be taken, i.e., by evacuating the contents of the container or installing a B-Kit.	• One-ton containers are visually inspected both internally and externally prior to being filled. • In addition, one-ton containers are hydrostatically tested every 5 years in accordance with DOT regulation. • Valve bodies and internal components are visually inspected prior to the container being filled. • Leak detectors located throughout the process area would trigger an automatic shutdown. • Manual shutdown buttons (E-Stops) and audible alarms are also positioned throughout the process area.	None.	2B
24. Filling station operator is filling containers during inclement weather (e.g., rain, high winds, etc.).	None. This should not be a problem as long as there is no leak.	• JCI has a company-wide inclement weather plan and employee training in place. • In the case of extremely violent weather, operations are not performed.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
25. Accident during storage or transfer of filled containers resulting in the container valve being "knocked off".	A release of up to 2000 pounds of chlorine could occur.	• A valve being knocked off after filling would be highly unlikely since the valves on both ton containers and cylinders are covered with a protective covering after being filled. • Forklifts would be the main plant vehicular traffic which would pose the risk of knocking off a valve. • Thus, clear lanes for forklift travel have been established. • This in conjunction with marked storage areas reduces the likelihood of this scenario.	None.	3A
26. Fire in storage area or near fill stations.	Container fuse plugs could melt resulting in the release of the entire contents of the container.	• No flammables are stored in or near the vicinity of the storage areas or fill stations. • ABC fire extinguishers located throughout the area.	None.	3A
27. Water in chlorine air pad system.	The continued presence can cause ferric chloride to develop plugging the chlorine process lines.	• The air padding system has a drier installed to prevent the inadvertent introduction of water into the system. • Moisture content is monitored daily via a dew point monitor.	None.	1A
28. Disgruntled employee commits an act of sabotage.	An act of sabotage could result in the release of a large amount of chlorine.	• JCI has a comprehensive security program to reduce the likelihood of sabotage by a disgruntled employee.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
29. Vacuum system failure.	There could be a minor release of chlorine vapor into the vat system.	• A vacuum alarm is present that serves to provide immediate notification of the loss of vacuum. • Filling would then halt until remedial measures are taken.	None.	1A
30. Failure of mitigation shutdown and alarm systems (i.e., railcar valve closure system, audible alarms, and actuated valves).	A possible unchecked release could occur due to the mitigation shutdown and alarm systems not automatically activating.	• This scenario is considered highly unlikely as all mitigation systems are both checked daily and used throughout the day. • In addition, manual shutdown procedures would be activated.	None.	2A
31. Failure of mitigation gas detection system (i.e., sensors).	There could be a release of product that could go unnoticed until it is picked up by another sensor.	• This scenario is considered highly unlikely since the sensors are checked daily, and a span calibration test is conducted every 90 days. • Since there are multiple sensors strategically located throughout the facility, it is highly unlikely that they would all fail at the same time. • In addition, there are manual emergency shutdown buttons (E-Stops) located throughout the facility.	Check calibration gas expiration dates and discard any expired calibration gases. Verify that procedures are in place to check expiration dates.	1A
32. Spare sensor parts are not available.	There could be a release of product that could go unnoticed if there was not a spare sensor immediately available to replace a defective sensor.	• Until a replacement sensor is received, the area without the sensor would be monitored frequently by human means.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
33. Sensor is improperly set.	There could be a release of product that could go unnoticed if the sensor wasn't properly set and until it is picked up by another sensor.	• This scenario is considered highly unlikely since the sensors are checked daily, and a span calibration test is conducted every 90 days. • Set points are programmed by the manufacturer and labeled on the sensor. • Since there are multiple sensors strategically located throughout the facility, it is highly unlikely that they would all be improperly set. • In addition, there are manual emergency shutdown buttons (E-Stops) located throughout the facility.	Check all sensors to verify that the set points programmed by the manufacturer are labeled on the sensor.	1A
34. CL2 lines are not properly identified.	Not applicable since the only compressed gas handled by this facility is chlorine.	• Not applicable since the only compressed gas handled by this facility is chlorine.	None.	1A
35. Eye wash station is not available.	An employee who was exposed to a chemical could be exposed slightly longer until he/she reached another eye wash station.	• This scenario is considered highly unlikely since there are multiple eye wash stations strategically located throughout the facility and each one is checked for operability weekly.	None.	1A
36. Improper tools are used in the processing of chlorine containers (i.e., filling, changing valves and fuse plugs, etc.).	Damage could be done to the valve or fuse plug on the container which could render the valve or fuse plug inoperable.	• JCI only uses tools specifically designed for each step in the containing processing operations.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
37. CL2 alarm sounds and there is no leak.	None, since this would simply indicate a possible equipment malfunction which would be immediately addressed. No release of product would be expected.	• A daily check of the entire mitigation system to include the alarms is conducted to assure the proper operation of each component of the mitigation system.	None.	1A
38. Emergency response equipment is not properly stored outside of the expected release areas (i.e., in a "safe/cold zone").	In the event of a release, access to emergency response equipment would not be available in which case outside emergency response assistance would be needed which would delay the response time.	• JCI's emergency response plan requires that all emergency response equipment be properly stored in a "safe/cold zone" outside of any expected release areas. • A comprehensive inspection of all emergency response equipment to include the proper storage location is conducted on a monthly basis.	None.	1A
39. Local emergency response agencies (i.e., Fire Department, Police Department, etc.) are unfamiliar with facility operations to include the products handled and their associated hazards.	The ability of the local emergency response agencies to effectively respond and or provide assistance to JCI in the event of a release would be severely impacted.	• JCI's emergency response plan requires that Coordination Agreements and or Memorandums of Understanding are in place between JCI and all applicable local emergency response agencies.	Verify that Coordination Agreements and or Memorandums of Understanding are in place between JCI and applicable local emergency response agencies.	1A
40. Systems are not inspected regularly.	The potential for the failure of individual equipment or entire systems would increase.	• JCI has an in-depth Mechanical Integrity and Preventative Maintenance program in which all systems, operations, equipment, etc. are inspected on either a daily, weekly, monthly, quarterly, and or etc. basis as necessary.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
41. PPE fails.	An employee could be exposed to chlorine.	• This scenario is considered highly unlikely since all PPE is inspected on a regular basis.	None.	3A
42. Pipe hangers fail.	The integrity of the piping system that it is supporting could potentially be compromised.	• JCI has an in-depth Mechanical Integrity and Preventative Maintenance program in which all systems, operations, equipment, etc. are inspected on either a daily, weekly, monthly, quarterly, and or etc. basis as necessary. • In addition, since there are multiple pipe hangers supporting each piece of pipe, it is highly unlikely that they would all fail at the same time. • Even if one pipe hanger were to fail, it is highly unlikely that the integrity of the piping system would be compromised.	None.	2A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
43. There is a lack of or failure of controls on employees in the workplace.	Chlorine repackaging operations could be compromised which could result in a release of chlorine. Depending on the size of the release, this could result in either acute and or chronic health effects to any exposed employees to include eyes, skin, throat and lungs.	• JCI has an in-depth employee safety training program to include new employee indoctrination, job instruction training, and periodic (refresher) training. • In addition, no one is allowed to work in our compressed gas operations unless they are thoroughly trained in all aspects of the compressed gas operations. • Lastly, supervisors closely monitor the activities of all employees throughout the workday.	None.	3A
44. Changes in technology, equipment, and or procedures are not communicated to employees.	The potential for improperly operating the system and or equipment could result in a release, damage to equipment, and or exposure/injury to an employee.	• JCI has formal Management of Change, Pre-Startup Safety Review, Employee Safety Training, and Employee Participation programs under OSHA's PSM program and all changes are promptly communicated to all employees and documented.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
45. Changes in system status are not communicated between employees when employees change tasks (i.e., if an employee begins a task, is called away, and returns after another employee has stepped in and performed part or all of the task originally being performed by the first employee), and or a shift change takes place.	The potential for improperly operating the system and or equipment could result in a release, damage to equipment, and or exposure/injury to an employee.	• JCI branch management continually stresses to all employees the importance of close communication between employees so as to ensure that situations do not develop that have the potential to result in a release of chlorine. • Employees are not permitted to leave the fill station while the container is being filled or once filled with the valve still in the open position.	None.	2B
46. Employee attempts to disconnect a cylinder or ton container that has been blown down without first closing the blow valve and opening the vacuum valve.	Potential release of a small residual amount of chlorine back through the blow line.	• A manual valve is located at the end of each line (blow down and vacuum) to prevent the release of product back through the blow line.	None.	1A
47. Employee attempts to remove a valve on a cylinder or ton container that has not been properly blown down and vacuumed.	Potential release of a small residual amount of chlorine remaining in the cylinder or ton container.	• A vacuum gauge is located at the blow down/vacuum station to indicate and confirm that the container has a proper vacuum.	None.	1B

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
48. There is a power failure.	The entire compressed gas repackaging system, to include the railcars, shuts down thereby shutting down the flow of chlorine. No release would result from this.	• The mitigation system is designed to shut down in the event of a loss of power. • As part of this, the air system will also shut down, resulting in the closure of all actuated valves in the compressed gas system.	None.	1A
49. The rupture disc in an expansion chamber ruptures.	Any chlorine trapped in the lines would be released into the expansion chamber. No release would result from this.	• All lines are blown down and vacuumed at the end of each day preventing the buildup of pressure in the lines. • It should be noted that if a rupture disc in an expansion chamber does rupture, that it has functioned as designed.	None.	1A
50. A whip on a ton or cylinder ruptures while the container is being filled and before the container is completely filled.	A release of chlorine up to and including the contents of the container would be released.	• Only whips meeting industry standards for chlorine are purchased and used. • It is also JCI's policy that all whips be replaced every 2 years. • All whips are also visually inspected prior to use at the beginning of each work day and are monitored throughout the day. • All whips are also blown down and vacuumed at the end of each work day to prevent the buildup of pressure in the whips.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
51. A leak develops at a railcar while the railcar is being connected.	There could be a minor release of chlorine.	• All rail cars are regulated by the DOT and are thoroughly inspected by the supplier prior to filling and shipping them to us. • Since JCI does not open any valves on a railcar until it is confirmed that there are no leaks during the connection process, JCI would first confirm that all connections and valve packings are tight, and if the leak still exists thereafter, a C-Kit would be installed and the supplier would be contacted for assistance. • All JCI employees performing railcar connection operations are required to wear a full-face respirator to prevent exposure in the event a leak develops during the connection process.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
52. A leak develops at a railcar while it is being disconnected.	There could be a minor release of chlorine.	• Prior to disconnecting a railcar, the entire system to include the railcar is shutdown, and all lines are blow down and vacuumed. • The vacuum gauge at the railcar platform is checked to verify that a complete vacuum has been applied prior to disconnecting the whip from the railcar. • All JCI employees performing railcar disconnection operations are required to wear a full-face respirator to prevent exposure in the event a leak develops during the disconnection process.	None.	1A
53. What if the wrong whip is used either at the filling stations or at the railcar.	The whip could fail resulting in the release of chlorine.	• Only whips meeting industry standards for chlorine are purchased and used. • A Certificate of Conformance from the manufacturer accompanies each whip purchased and is verified by the facility upon receipt and prior to being put into service.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
54. Chlorine ton containers or cylinders are not completely blown down and vacuumed prior to refilling them.	As the volume of chlorine in the container decreases, the concentration of nitrogen trichloride in the remaining liquid increases and given the properties of nitrogen trichloride, there is the potential for an explosion and the subsequent release of any remaining product.	• In accordance with JCI’s SOP for Repackaged Compressed Gases, each and every container, both tons and cylinders, is completely blown down and vacuumed and in doing this, the potential for any accumulation of nitrogen trichloride in the container is extremely unlikely if not impossible.	None.	3A

TABLE 12.2 - Results of the "What If?" Process Hazard Analysis for the Chlorine Storage/Distribution System

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
1. Facility traffic, visiting traffic or delivery vehicle (e.g., forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with a chlorine rail car.	There could be a release of anywhere from less than one pound to a full railcar of chlorine. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• This scenario is unlikely since there is a 5-MPH speed limit for facility traffic. • Rail cars rarely cross the roadway coming into the site. • In addition, the rail car docking area is off limits to facility traffic. • There is also fencing around all of the railcars.	None.	3A
2. Facility traffic, visiting traffic or delivery vehicle (e.g., forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with stored chlorine ton containers or cylinders.	There could be a release of anywhere from less than one pound to one ton of chlorine. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• All chlorine ton containers and cylinders are stored in Conex boxes and therefore are inaccessible by any type of traffic.	None.	3A
3. Facility traffic, visiting traffic or delivery vehicle (e.g., forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with the chlorine transfer piping system.	There could be a minor release of chlorine.	• With the exception of forklifts, all chlorine transfer piping systems are inaccessible by facility traffic, visiting traffic or delivery vehicles. • In the case of forklifts, chlorine transfer piping systems are not in forklift traffic patterns.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
4. A ton container or cylinder in storage develops a leak in either the liquid or vapor phase (either during working or non-working hours to include over the weekend).	There could be a release of anywhere from less than one pound to one ton of chlorine. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	2A
5. A "residue last contained" ton container or cylinder is received back at the facility and subsequently develops a leak in either the liquid or vapor phase prior to the container being processed (either during working or non-working hours to include over the weekend).	There could be a minor release of chlorine.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	1A
6. Catastrophic failure of a one-ton container.	A catastrophic failure of a one-ton container would result in the release of up to one-ton of chlorine.	• All containers undergo thorough hydrostatic testing and other preventive maintenance procedures.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
7. Catastrophic failure of a 150-pound cylinder.	A catastrophic failure of a 150-pound cylinder would result in the release of up to 150 pounds of chlorine.	• All containers undergo thorough hydrostatic testing and other preventive maintenance procedures.	None.	3A
8. A ton container or cylinder develops a slow leak in the liquid or vapor phase due to an external event.	There could be a minor release of chlorine.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	1A
9. A ton container develops a catastrophic leak in the liquid or vapor phase due to an external event.	A catastrophic failure of a ton container would result in the release of 2000 pounds of chlorine. Under a catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
10. A cylinder develops a catastrophic leak in the liquid or vapor phase due to an external event.	A catastrophic failure of a 150-pound cylinder would result in the release of 150 pounds of chlorine. Under a catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility’s auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	3A
11. Accident during storage or transfer of filled containers resulting in the container valve being "knocked off".	A release of up to 2000 pounds of chlorine could occur.	• A valve being knocked off after filling would be highly unlikely since the valves on both ton containers and cylinders are covered with a protective covering after being filled. • Forklifts would be the main plant vehicular traffic which would pose the risk of knocking off a valve. • Thus, clear lanes for forklift travel have been established. • This in conjunction with marked storage areas reduces the likelihood of this scenario.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
12. Ton container or cylinder falls off either the forklift or the trailer during the loading or unloading process.	This could result in a container striking the ground with sufficient force to cause a leak or release.	• Ton containers and cylinders are equipped with protective bonnets over the valve. • In addition the ends of the ton containers have a concave configuration. • Both ton containers and cylinders are constructed of carbon steel and are designed to withstand damage caused by other than normal circumstances. • As such, this scenario is considered highly unlikely.	None.	3A
13. Fire in storage area.	Container fuse plugs could melt resulting in the release of the entire contents of the container.	• No flammables are stored in or near the vicinity of the storage areas or fill stations. • ABC fire extinguishers located throughout the area.	None.	3A
14. Disgruntled employee commits sabotage.	An act of sabotage could result in the release of a large amount of chlorine.	• JCI has a comprehensive security program to reduce the likelihood of sabotage by a disgruntled employee.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
15. Chlorine ton containers or cylinders are stored in close proximity to incompatible materials and develop a leak.	If chlorine were to come in contact with any reducing agents, organic materials, or alkalis, then hazardous decomposition products such as hydrogen chloride and hypochlorous acid could be formed.	• All chlorine ton containers and cylinders are stored outdoors in Conex boxes dedicated solely for the storage of chlorine containers. • As such, there are no circumstances under which chlorine can come in contact with any incompatible materials even if a leak developed. • Each Conex box is also equipped with a gas detection sensor.	None.	1A
16. There is a lack of or failure of controls on employees in the workplace.	Chlorine storage and distributions operations could be compromised which could result in a release of chlorine. Depending on the size of the release, this could result in either acute and or chronic health effects to any exposed employees to include eyes, skin, throat and lungs.	• JCI has an in-depth employee safety training program to include new employee indoctrination, job instruction training, and periodic (refresher) training. • In addition, no one is allowed to work in our compressed gas operations unless they are thoroughly trained in all aspects of the compressed gas operations. • Lastly, supervisors closely monitor the activities of all employees throughout the workday.	None.	3A

TABLE 12.3 - Results of the "What If?" Process Hazard Analysis for the Sulfur Dioxide Storage/Distribution System

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
1. Facility traffic, visiting traffic or delivery vehicle (e.g., forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with a sulfur dioxide railcar.	There could be a release of anywhere from less than one pound to a full railcar of sulfur dioxide. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• This scenario is unlikely since there is a 5-MPH speed limit for facility traffic. • Rail cars rarely cross the roadway coming into the site. • In addition, the rail car docking area is off limits to facility traffic. • There is also fencing around all of the railcars.	None.	3A
2. Facility traffic, visiting traffic or delivery vehicle (e.g., forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with stored sulfur dioxide ton containers or cylinders.	There could be a release of anywhere from less than one pound to one ton of sulfur dioxide. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• All sulfur dioxide ton containers and cylinders are stored in Conex boxes and therefore are inaccessible by any type of traffic.	None.	3A
3. Facility traffic, visiting traffic or delivery vehicle (e.g., forklifts, tractors, tank trucks, cars, delivery trucks, etc.), in bound or out bound, has a transportation accident with the sulfur dioxide transfer piping system.	There could be a minor release of sulfur dioxide.	• With the exception of forklifts, all sulfur dioxide transfer piping systems are inaccessible by facility traffic, visiting traffic or delivery vehicles. • In the case of forklifts, sulfur dioxide transfer piping systems are not in forklift traffic patterns.	None.	2A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
4. A ton container or cylinder in storage develops a leak in either the liquid or vapor phase (either during working or non-working hours to include over the weekend).	There could be a release of anywhere from less than one pound to one ton of sulfur dioxide. Under a major or catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	2A
5. A "residue last contained" ton container or cylinder is received back at the facility and subsequently develops a leak in either the liquid or vapor phase prior to the container being processed.	There could be a minor release of sulfur dioxide.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	1A
6. Catastrophic failure of a one-ton container.	A catastrophic failure of a one-ton container would result in the release of up to one-ton of sulfur dioxide.	• All containers undergo thorough hydrostatic testing and other preventive maintenance procedures.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
7. Catastrophic failure of a 150-pound cylinder.	A catastrophic failure of a 150-pound cylinder would result in the release of up to 150 pounds of sulfur dioxide.	• All containers undergo thorough hydrostatic testing and other preventive maintenance procedures.	None.	3A
8. A ton container or cylinder develops a slow leak in the liquid or vapor phase due to an external event.	There could be a minor release of sulfur dioxide.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	1A
9. A ton container develops a catastrophic leak in the liquid or vapor phase due to an external event.	A catastrophic failure of a ton container would result in the release of 2000 pounds of sulfur dioxide. Under a catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
10. A cylinder develops a catastrophic leak in the liquid or vapor phase due to an external event.	A catastrophic failure of a 150-pound cylinder would result in the release of 150 pounds of sulfur dioxide. Under a catastrophic release the JCI Emergency Response Procedures (ERP) would be initiated. The plume direction would be noted and reported to 911. Next the facility Emergency Response Coordinator would initiate plant evacuation.	• Gas detection sensors are located in all ton container and cylinder storage areas. • The sensors are tied into both audible and visible alarms as well as the facility's auto-dialer system. • In addition, all ton containers and cylinders are hydrostatically testing every 5 years in accordance with DOT regulations and are thoroughly inspected prior to being filled.	None.	3A
11. Accident during storage or transfer of filled containers resulting in the container valve being "knocked off".	A release of up to 2000 pounds of sulfur dioxide.	• A valve being knocked off after filling would be highly unlikely since the valves on both ton containers and cylinders are covered with a protective covering after being filled. • Forklifts would be the main plant vehicular traffic which would pose the risk of knocking off a valve. • Thus, clear lanes for forklift travel have been established. • This in conjunction with marked storage areas reduces the likelihood of this scenario.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
12. Ton container or cylinder falls off either the forklift or the trailer during the loading or unloading process.	This could result in a container striking the ground with sufficient force to cause a leak or release.	• Ton containers and cylinders are equipped with protective bonnets over the valve. • In addition the ends of the ton containers have a concave configuration. • Both ton containers and cylinders are constructed of carbon steel and are designed to withstand damage caused by other than normal circumstances. • As such, this scenario is considered highly unlikely.	None.	3A
13. Fire in storage area.	Container fuse plugs could melt resulting in the release of the entire contents of the container.	• No flammables are stored in or near the vicinity of the storage areas or fill stations. • ABC fire extinguishers located throughout the area.	None.	3A
14. Disgruntled employee commits sabotage.	An act of sabotage could result in the release of a large amount of sulfur dioxide.	• JCI has a comprehensive security program to reduce the likelihood of sabotage by a disgruntled employee.	None.	3A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
15. Sulfur dioxide ton containers or cylinders are stored in close proximity to incompatible materials and develop a leak.	If sulfur dioxide were to come in contact with any strong alkaline materials, then hazardous decomposition or combustion products such as sulfur trioxide or sulfuric acid could be formed.	• All sulfur dioxide containers and cylinders are stored outdoors in Conex boxes dedicated solely for the storage of sulfur dioxide containers. • As such, there are no circumstances under which sulfur dioxide can come in contact with any incompatible materials even if a leak developed. • Each Conex box is also equipped with a gas detection sensor.	None.	1A
16. There is a lack of or failure of controls on employees in the workplace.	Sulfur dioxide storage and distributions operations could be compromised which could result in a release of sulfur dioxide. Depending on the size of the release, this could result in either acute and or chronic health effects to any exposed employees to include eyes, skin, throat and lungs.	• JCI has an in-depth employee safety training program to include new employee indoctrination, job instruction training, and periodic (refresher) training. • In addition, no one is allowed to work in our compressed gas operations unless they are thoroughly trained in all aspects of the compressed gas operations. • Lastly, supervisors closely monitor the activities of all employees throughout the workday.	None.	3A

TABLE 12.4 - Results of the "What If?" Process Hazard Analysis for the Sodium Hypochlorite Manufacturing System (Bleach Machine)

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
1. There is a leak from the chlorine supply piping.	There would be a minor release of chlorine limited to the contents of the bleach machine and supply piping.	• The bleach machine is charged only when the plant is manned. • There are chlorine sensors located throughout the plant to include in the bleach machine room. • If a chlorine leak is detected, an audible alarm is automatically activated and automatic shutoff valves stop the flow of chlorine, isolating the railcars and any containers being filled from the piping system. • Any excess chlorine in the bleach machine would flow to the blow vats. • The mitigation system can also be activated with manual Plant Emergency Stops (E-Stops) located throughout the plant.	None.	1A
2. The bleach machine recycle tank is over-chlorinated.	The oxidation reduction potential [ORP] or the temperature of the solution in the bleach machine could increase. No release would result from this.	• The bleach machine is equipped with ORP and temperature sensors. • If preset ORP and temperature set points are exceeded, the bleach machine mitigation system is automatically activated. • The mitigation system automatically shuts off the flow of chlorine, preventing over-chlorination.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
3. There is low caustic concentration in the bleach machine.	The bleach machine will self-adjust the chlorine flow to maintain the desired set point. No release would result from this.	• The bleach machine is equipped with ORP and temperature sensors. • If preset ORP and temperature set points are exceeded, the bleach machine mitigation system is automatically activated. • The mitigation system automatically shuts off the flow of chlorine, preventing over-chlorination.	None.	1A
4. Sodium hypochlorite leaks from bleach machine, transfer lines, or storage tanks and mixes with incompatible materials.	If sodium hypochlorite were to come in contact with any incompatible materials, hazardous decomposition products such as hypochlorous acid, chlorine or hydrochloric acid could be formed.	• The bleach machine, transfer lines, and storage tanks for sodium hypochlorite are isolated from any other products and processes. • As such, it is highly unlikely that sodium hypochlorite could mix with any other products.	None.	1A
5. The flow or circulation of the caustic soda solution is interrupted during chlorination.	If the flow rate drops below predetermined set points or is interrupted during chlorination, an alarm will sound and the flow control system will automatically shut down the flow of chlorine. No release would result from this.	• The bleach machine has control systems and alarms in place designed to monitor the flow of caustic soda and the temperature of the solution to automatically shut down the flow of chlorine if the flow rate drops below predetermined set points or is interrupted during chlorination.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
6. The pipes or vessels overheat.	Uncontrolled overheating could result in damage to the bleach machine and the associated piping systems which could result in a release of sodium hypochlorite.	• If the preset temperature set point is exceeded, an audible alarm is automatically activated and an automatic shutoff valve stops the flow of chlorine. • This immediately stops any overheating. • This mitigation system is backed up by manual emergency shutdown buttons (E-Stops) located throughout the plant.	None.	1A
7. The system over-pressurizes.	Excessive pressure could build up in the piping system causing the pipes to rupture.	• There are no pressure sources within the system except for the chlorine supply itself. • The flow pressure of chlorine is controlled via a predetermined set point on the compressor. • The bleach manufacturing process is a continuous flowing system that doesn’t allow for the buildup of pressure in the system.	None.	1A
8. There is a power failure.	The entire compressed gas system, to include the bleach manufacturing process, shuts down thereby shutting down the flow of chlorine. No release would result from this.	• The mitigation system is designed to shut down in the event of a loss of power. • As part of this, the air system will also shut down, resulting in the closure of all actuated valves in the compressed gas system.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
9. Human error occurs (i.e., manual valves throughout the bleach manufacturing system are not opened, set points for the strength of the solution are not properly programmed, the appropriate circulation system valves are not opened, etc.).	An alarm will sound indicating a system upset or error. No release would result from this.	• The bleach machine has built in safety features to include alarms designed to alert the operator of a system upset or error.	None.	1A
10. There is a low-level event in the recycle tank?	An alarm will sound indicating a low-level event in the recycle tank. A minor release of chlorine into the vat system could occur.	• The bleach machine has a built in alarm designed to alert the operator of a low-level event in the recycle tank. • In addition, the flow of chlorine would automatically shut down.	None.	2A
11. The solenoid to open the valve for the dilute caustic soda solution that reacts with the chlorine in the recycle tank malfunctions stopping the flow of caustic soda to the recycle tank.	A minor release of chlorine from the recycle tank into the blow vat could occur.	• The bleach machine has control systems and alarms in place designed to monitor the flow of caustic soda and the temperature of the solution to automatically shut down the flow of chlorine if there is an upset in the system. • Any chlorine remaining in the recycle tank would flow to the blow vats.	Verify that while the bleach machine is running that the valves in the vent line to the bleach blow vat being circulated are open.	1A
12. The vacuum breaker on the bleach recycle tank remains stuck in the open position.	A minor release of chlorine could occur.	• Recycle tanks no longer have vacuum breakers on them. • This was an older technology that is no longer needed. • As such, this can no longer happen.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
13. There is a lack of or failure of controls on employees in the workplace.	Sodium hypochlorite operations could be compromised which could result in a release of chlorine. Depending on the size of the release, this could result in either acute and or chronic health effects to any exposed employees to include eyes, skin, throat and lungs.	• JCI has an in-depth employee safety training program to include new employee indoctrination, job instruction training, and periodic (refresher) training. • In addition, no one is allowed to work in our sodium hypochlorite operations unless they are thoroughly trained in all aspects of the sodium hypochlorite operations. • Lastly, supervisors closely monitor the activities of all employees throughout the workday.	None.	3A

TABLE 12.5 - Results of the "What If?" Process Hazard Analysis for the Sodium Hypochlorite Manufacturing System (Make Vats)

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
1. There is a leak from the chlorine supply piping.	There would be a minor release of chlorine limited to the contents of the sodium hypochlorite make vat supply piping.	• The bleach make vats are charged only when the plant is manned. • There are chlorine sensors located throughout the plant to include in the bleach room. • If a chlorine leak is detected, an audible alarm is automatically activated and automatic shutoff valves stop the flow of chlorine, isolating the railcars and any containers being filled from the piping system. • The mitigation system can also be activated with manual Plant Emergency Stops (E-Stops) located throughout the plant.	None.	1A
2. The sodium hypochlorite make vats are over-chlorinated.	The oxidation reduction potential [ORP] or the temperature of the solution in the bleach make vats could increase which could potentially result in a release of chlorine.	• The bleach make vats are equipped with ORP and temperature sensors • If preset ORP and temperature set points are exceeded, the mitigation system is automatically activated. • The mitigation system automatically shuts off the flow of chlorine, preventing over-chlorination.	None.	2A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
3. There is a low-level event in the sodium hypochlorite make vats that exposes the chlorine supply pipe.	Chlorine could be released from the supply line.	• The sodium hypochlorite make vats are equipped with low level sensors. • If the level in the sodium hypochlorite make vats drops below the preset set point, an audible alarm is automatically activate and the mitigation system automatically shuts off the flow of chlorine to the make vats.	Verify that the low level set point on the bleach make vat(s) is programmed to be above the bottom of the sparger tube (supply pipe).	2A
4. The flow or circulation of the caustic soda solution is interrupted during chlorination.	A lengthy interruption to the continuous circulation of the caustic soda or sodium hypochlorite solution during chlorination could result in over-chlorination.	• The bleach make vats are equipped with ORP and temperature sensors. • If preset ORP and temperature set points are exceeded, the mitigation system is automatically activated. • The mitigation system automatically shuts off the flow of chlorine, preventing over-chlorination.	None.	1A
5. Sodium hypochlorite leaks from make vats, transfer lines, or storage tanks and mixes with incompatible materials.	If sodium hypochlorite were to come in contact with any incompatible materials, hazardous decomposition products such as hypochlorous acid, chlorine or hydrochloric acid could be formed.	• The bleach make vats, transfer lines, and storage tanks for sodium hypochlorite are isolated from any other products and processes. • As such, it is highly unlikely that sodium hypochlorite could mix with any other products.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
6. The pipes or vessels overheat.	Uncontrolled overheating could result in damage to the bleach make vats and the associated piping systems which could result in a release of sodium hypochlorite.	• If the preset temperature set point is exceeded, an audible alarm is automatically activated and an automatic shutoff valve stops the flow of chlorine. • This immediately stops any overheating. • This mitigation system is backed up by manual emergency shutdown buttons (E-Stops) located throughout the plant.	None.	2A
7. The system over-pressurizes.	Excessive pressure could build up in the piping system causing the pipes to rupture.	• There are no pressure sources within the system therefore over-pressurization is not practically possible.	None.	1A
8. There is a power failure.	The entire compressed gas system, to include the bleach manufacturing process, shuts down thereby shutting down the flow of chlorine. No release would result from this.	• The mitigation system is designed to shut down in the event of a loss of power. • As part of this, the air system will also shut down, resulting in the closure of all actuated valves in the compressed gas system.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
9. Human error occurs (i.e., manual valves throughout the bleach manufacturing system are not opened, the appropriate circulation system valves are not opened, etc.).	Overheating and a subsequent release of chlorine could occur.	• If the preset temperature set point is exceeded, an audible alarm is automatically activated and an automatic shutoff valve stops the flow of chlorine. • This immediately stops any overheating. • This mitigation system is backed up by manual emergency shutdown buttons (E-Stops) located throughout the plant.	None.	1A
10. There is a lack of or failure of controls on employees in the workplace.	Sodium hypochlorite operations could be compromised which could result in a release of chlorine. Depending on the size of the release, this could result in either acute and or chronic health effects to any exposed employees to include eyes, skin, throat and lungs.	• JCI has an in-depth employee safety training program to include new employee indoctrination, job instruction training, and periodic (refresher) training. • In addition, no one is allowed to work in our sodium hypochlorite operations unless they are thoroughly trained in all aspects of the sodium hypochlorite operations. • Lastly, supervisors closely monitor the activities of all employees throughout the workday.	None.	3A

TABLE 12.6 - Results of the "What If" Process Hazard Analysis for the Sodium Bisulfite Manufacturing System (Make Vats)

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
1. There is a leak from the sulfur dioxide supply piping.	There would be a minor release of sulfur dioxide limited to the contents of the sodium bisulfite make vat supply piping.	• The sodium bisulfite make vats are charged only when the plant is manned. • There are sulfur dioxide sensors located throughout the plant to include in the sodium bisulfite room. • If a sulfur dioxide leak is detected, an audible alarm is automatically activated and automatic shutoff valves stop the flow of sulfur dioxide, isolating the railcars and any containers being filled from the piping system. • The mitigation system can also be activated with manual Plant Emergency Stops (E-Stops) located throughout the plant.	None.	1A
2. The sodium bisulfite make vats are over-sulfonated.	The pH or the temperature of the solution in the sodium bisulfite make vats could increase which could potentially result in a release of sulfur dioxide.	• The sodium bisulfite make vats are equipped with pH and temperature sensors. • If preset pH and temperature set points are exceeded, the mitigation system is automatically activated. • The mitigation system automatically shuts off the flow of sulfur dioxide, preventing over-sulfonation.	None.	2A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
3. There is a low-level event in the sodium bisulfite make vats that exposes the sulfur dioxide supply pipe.	Sulfur dioxide could be released from the supply line.	• The sodium bisulfite make vats are equipped with low level sensors. • If the level in the sodium bisulfite make vats drops below the preset set point, an audible alarm is automatically activate and the mitigation system automatically shuts off the flow of sulfur dioxide to the make vats.	Verify that the low level set point on the sodium bisulfite make vat(s) is programmed to be above the bottom of the sparger tube (supply pipe).	2A
4. The flow or circulation of the caustic soda solution is interrupted during sulfonation.	A lengthy interruption to the continuous circulation of the caustic soda or sodium bisulfite solution during sulfonation could result in over-sulfonation.	• The sodium bisulfite make vats are equipped with pH and temperature sensors. • If preset pH and temperature set points are exceeded, the mitigation system is automatically activated. • The mitigation system automatically shuts off the flow of sulfur dioxide, preventing over-sulfonation.	None.	1A
5. Sodium bisulfite leaks from make vats, transfer lines, or storage tanks and mixes with incompatible materials.	If sodium bisulfite were to come in contact with any incompatible materials, hazardous decomposition products such as sulfur dioxide could be formed.	• The sulfur dioxide make vats, transfer lines, and storage tanks for sodium bisulfite are isolated from any other products and processes. • As such, it is highly unlikely that sodium bisulfite could mix with any other products.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
6. The pipes or vessels overheat.	Uncontrolled overheating could result in damage to the sodium bisulfite make vats and the associated piping systems which could result in a release of sodium bisulfite.	• If the preset temperature set point is exceeded, an audible alarm is automatically activated and an automatic shutoff valve stops the flow of sulfur dioxide. • This immediately stops any overheating. • This mitigation system is backed up by manual emergency shutdown buttons (E-Stops) located throughout the plant.	None.	2A
7. The system over-pressurizes.	Excessive pressure could build up in the piping system causing the pipes to rupture.	• There are no pressure sources within the system therefore over-pressurization is not practically possible.	None.	1A
8. There is a power failure.	The entire compressed gas system, to include the sodium bisulfite manufacturing process, shuts down thereby shutting down the flow of sulfur dioxide. No release would result from this.	• The mitigation system is designed to shut down in the event of a loss of power. • As part of this, the air system will also shut down, resulting in the closure of all actuated valves in the compressed gas system.	None.	1A

WHAT IF?	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION	RANK
9. Human error occurs (i.e., manual valves throughout the sodium bisulfite manufacturing system are not opened, the appropriate circulation system valves are not opened, etc.).	Overheating and a subsequent release of sulfur dioxide could occur.	• If the preset temperature set point is exceeded, an audible alarm is automatically activated and an automatic shutoff valve stops the flow of sulfur dioxide. • This immediately stops any overheating. • This mitigation system is backed up by manual emergency shutdown buttons (E-Stops) located throughout the plant.	None.	1A
10. There is a lack of or failure of controls on employees in the workplace.	Sodium bisulfite operations could be compromised which could result in a release of sulfur dioxide. Depending on the size of the release, this could result in either acute and or chronic health effects to any exposed employees to include eyes, skin, throat and lungs.	• JCI has an in-depth employee safety training program to include new employee indoctrination, job instruction training, and periodic (refresher) training. • In addition, no one is allowed to work in our sodium bisulfite operations unless they are thoroughly trained in all aspects of the sodium bisulfite operations. • Lastly, supervisors closely monitor the activities of all employees throughout the workday.	None.	3A

TABLE 12.a.7 - Results of the External Events Analysis

EVENT	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION
1. Aircraft impact	If it impacted the rail car storage area, a release of the entire contents of up to 5 rail cars of chlorine could occur.	• The facility is 8 miles from the Manchester Airport. • Commercial aircraft fly over the facility from time to time. • However, the possibility of aircraft impact is considered remote (extremely unlikely).	None.
2. Avalanche	Not applicable.	• The facility and its delivery area are not in an avalanche area.	None.
3. Coastal erosion	Not applicable.	• The facility is located in an inland area. • Therefore there is no potential for coastal erosion to impact the facility.	None.
4. Drought	No release would be expected.	• The facility uses water to formulate bleach and sodium bisulfite, and for cooling processes. • During severe droughts, the plant water supply may be curtailed. • In an extreme case, if the water supply were completely cut, bleach and sodium bisulfite production would be discontinued for some time.	None.
5. External flooding	No release would be expected.	• JCI has an Inclement Weather Plan contained in the facility’s Contingency Plan that would be implemented.	None.
6. Extreme winds or tornadoes	High winds could cause filled containers to be damaged, resulting in a release of chlorine and or sulfur dioxide.	• The facility isn’t located in a tornado area. • The major impact if a tornado did occur would be high wind damage. • JCI has an Inclement Weather Plan contained in the facility’s Contingency Plan that would be implemented.	None.
7. Fire	Container fuse plugs would melt resulting in the release of the	• There is a wet sprinkler system in the plant.	None.

EVENT	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION
	entire contents of the container.	• Fire extinguishers are located throughout the plant and the employees receive annual training in their use. • In addition, all flammable materials are properly stored in flammable cabinets.	
8. Fog	No release would be expected.	• Occasional heavy fog occurs in this area for short periods, usually early in the day. • When this occurs, operations, including deliveries, are suspended until the fog lifts.	None.
9. Forest fire	Not applicable.	• The facility is not located near a forest.	None.
10. Frost	Extreme frost may freeze some pipes. PVC pipes may become brittle and as a consequence may break at a later time resulting in a release.	• After a frost occurs, all system components (piping, valves, etc.) are inspected prior to beginning filling or transfer operations.	None.
11. Hail	No release would be expected.	• Historically hailstorms are infrequent and not severe.	None.
12. High tide/High lake/High river	No release would be expected.	• There are no bodies of water adjacent to the facility.	None.
13. High summer temperatures	Prolonged direct exposure of chlorine or sulfur dioxide containers to the sun could be a hazard. Container fuse plugs could melt resulting in the release of the entire contents of the container.	• The maximum summer temperature for the area is 95°F - 100°F. • All chlorine and sulfur dioxide containers are stored in separate Conex boxes.	None.
14. Hurricane	No release would be expected.	• The facility isn't in a hurricane area. • The major impact if a hurricane did occur would be flooding. • See Item 5 above. • JCI has an Inclement Weather Plan contained in the facility's Contingency Plan that would be implemented.	None.
15. Ice cover	No release would be expected.	• After an ice covering occurs, all system components (piping, valves, etc.) are inspected prior to beginning filling or transfer operations.	None.

EVENT	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION
16. Industrial or Military facility accident	No release would be expected. The facility may need to be evacuated.	• The plant mitigation system would be activated shutting down all plant operations.	None.
17. Internal flooding	No release would be expected.	• The possibility for internal flooding (broken water line, etc.) is considered remote.	None.
18. Landslide	Not applicable.	• The facility is not located in a landslide area.	None.
19. Lightning	No release would be expected.	• Facility equipment is adequately protected.	None.
20. Low lake or river level	No release would be expected.	• None required given that a low lake or river level would not have any impact on JCI.	None.
21. Low winter temperature	No release would be expected.	• The lowest average temperature that occurs during the winter is 20ºF. • Chlorine and sulfur dioxide aren't affected because the minimum freezing point of any of the two chemicals is -102F (-74C) and the minimum boiling point of any of the two chemicals is 14F (-10C).	None.
22. Meteorite impact	If it impacted the rail car storage area, a release of the entire contents of up to 5 rail cars of chlorine could occur.	• If intelligence was received of a pending meteorite impact, JCI would take necessary steps to ship any rail cars back to the supplier. • However, the possibility of meteorite impact is considered remote (extremely unlikely).	None.
23. Missile impact	If it impacted the rail car storage area, a release of the entire contents of up to 5 rail cars of chlorine could occur.	• If intelligence was received of a pending missile impact, JCI would take necessary steps to ship any rail cars back to the supplier. • However, the possibility of missile impact is considered remote (extremely unlikely).	None.
24. Nearby pipeline accident	No release would be expected.	• The plant mitigation system would be activated shutting down all plant operations.	None.
25. Intense precipitation	No release would be expected.	• JCI has an Inclement Weather Plan contained in the facility's	None.

EVENT	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION
		Contingency Plan that would be implemented.	
26. Release of chemicals from on-site storage	No release would be expected.	• All chemicals and processes are segregated based on compatibility. • In the event of a release, the plant mitigation system would be activated shutting down all plant operations.	None.
27. River diversion	No release would be expected.	• None required given that a river diversion would not have any impact on JCI.	None.
28. Sabotage	An act of sabotage could result in the release of a large amount of chlorine and or sulfur dioxide.	• JCI has a comprehensive security program to reduce the likelihood of sabotage by a disgruntled employee.	None.
29. Sandstorm	Not applicable.	• The facility is not located in a sandstorm area.	None.
30. Seiche (lake wave)	No release would be expected.	• JCI has an Inclement Weather Plan contained in the facility's Contingency Plan that would be implemented.	None.
31. Seismic activity	Not applicable.	• The facility is not located in a seismically active area.	None.
32. Shipwreck	Not applicable.	• The facility is not located on a navigable waterway.	None.
33. Snow	No release would be expected.	• JCI has an Inclement Weather Plan contained in the facility's Contingency Plan that would be implemented.	None.
34. Soil shrink, swell, or consolidation	No release would be expected.	• The plant mitigation system would be activated shutting down all plant operations.	None.
35. Storm surge	No release would be expected.	• JCI has an Inclement Weather Plan contained in the facility's Contingency Plan that would be implemented.	None.
36. Terrorist attack	A terrorist attack could result in the release of a large amount of chlorine or sulfur dioxide.	• JCI has a comprehensive security program to reduce the likelihood of sabotage by a disgruntled employee.	None.
37. Transportation accident	A transportation accident could result in a release of the entire contents of several containers.	• All containers used to ship HHCs are manufactured and maintained in accordance with DOT	None.

EVENT	CONSEQUENCE	SAFEGUARDS	RECOMMENDATION
		specifications and regulations. • All drivers who carry HHCs have a Commercial Driver's License (CDL) with Hazardous Material (HazMat) endorsement as required by the USDOT. • Each driver receives extensive training regarding the HHCs to be transported.	
38. Tsunami (tidal wave)	No release would be expected.	• JCI has an Inclement Weather Plan contained in the facility's Contingency Plan that would be implemented.	None.
39. Toxic gas	No release would be expected other the toxic gas itself.	• All chemicals and processes are segregated based on compatibility. • In the event of a release, the plant mitigation system would be activated shutting down all plant operations.	None.
40. Turbine generated missile	If it impacted the rail car storage area, a release of the entire contents of up to 5 rail cars of chlorine could occur.	• If intelligence was received of a pending turbine generated missile impact, JCI would take necessary steps to ship any rail cars back to the supplier. • However, the possibility of a turbine generated missile impact is considered remote (extremely unlikely).	None.
41. Volcanic activity	Not applicable.	• The facility is not located in an area of volcanic activity.	None.
42. War	War could result in the release of a large amount of chlorine and or sulfur dioxide.	• If intelligence was received of a pending war, JCI would take necessary steps to ship any rail cars back to the supplier.	None.
43. Waves	Not applicable.	• The facility is not located on a waterway.	None.

FIGURE 12.a - Description of Qualitative Rankings

SEVERITY OF CONSEQUENCE

Rank	Examples of Severity
Low	Chemical is expected to move into the surrounding environment in negligible concentrations. Injuries expected only for exposure over extended periods of when individual personal health conditions create complications.
Medium	Chemical is expected to move into the surrounding environment in concentrations sufficient to cause serious injuries and/or deaths unless prompt and effective corrective action is taken. Death and/or injuries expected only for exposure over extended periods or when individual personal health conditions create complications.
High	Chemical is expected to move into the surrounding environment in concentration sufficient to cause serious injuries and/or deaths upon exposure. Large numbers of people expected to be affected.

LIKELIHOOD OF OCCURRENCE

Rank	Examples of Likelihood
Low	Probability of occurrence considered unlikely during the expected lifetime of the facility assuming normal operation and maintenance.
Medium	Probability of occurrence considered possible during the expected lifetime of the facility.
High	Probability of occurrence considered sufficiently high to assume event will occur at least once during the expected lifetime of the facility.

FIGURE 12.a.1 - Results of the Qualitative Rankings for the Chlorine Repackaging System

SEVERITY OF CONSEQUENCE

3	HIGH	1, 2, 7, 10, 20, 21, 25, 26, 28, 41, 43, 50, 53		
2	MEDIUM	3, 5, 11, 16, 18, 22, 23, 30, 42	45	
1	LOW	4, 6, 8, 9, 12, 13, 14, 15, 17, 19, 24, 27, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 44, 46, 48, 49, 51, 52	47	
		LOW A	MEDIUM B	HIGH C

LIKELIHOOD OF OCCURANCE

FIGURE 12.a.2 - Results of the Qualitative Rankings for the Chlorine Storage and Distribution System

SEVERITY OF CONSEQUENCE

3	HIGH	1, 2, 6, 7, 9, 10, 11, 12, 13, 14, 16		
2	MEDIUM	4		
1	LOW	3, 5, 8, 15		
		LOW A	MEDIUM B	HIGH C

LIKELIHOOD OF OCCURANCE

FIGURE 12.a.3 - Results of the Qualitative Rankings for the Sulfur Dioxide Storage and Distribution System

SEVERITY OF CONSEQUENCE

3	HIGH	1, 2, 6, 7, 9, 10, 11, 12, 13, 14, 16		
2	MEDIUM	4		
1	LOW	3, 5, 8, 15		
		LOW A	MEDIUM B	HIGH C

LIKELIHOOD OF OCCURANCE

FIGURE 12.a.4 - Results of the Qualitative Rankings for the Sodium Hypochlorite Manufacturing System (Bleach Machine)

SEVERITY OF CONSEQUENCE

3 HIGH	13		
2 MEDIUM	10		
1 LOW	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12		
	LOW A	MEDIUM B	HIGH C

LIKELIHOOD OF OCCURANCE

FIGURE 12.a.5 - Results of the Qualitative Rankings for the Sodium Hypochlorite Manufacturing System (Make Vats)

SEVERITY OF CONSEQUENCE

3	HIGH	10		
2	MEDIUM	2, 3, 6		
1	LOW	1, 4, 5, 7, 8, 9		
		LOW A	MEDIUM B	HIGH C

LIKELIHOOD OF OCCURANCE

FIGURE 12.a.6 - Results of the Qualitative Rankings for the Sodium Bisulfite Manufacturing System (Make Vats)

SEVERITY OF CONSEQUENCE

3 HIGH	10		
2 MEDIUM	2, 3, 6		
1 LOW	1, 4, 5, 7, 8, 9		
	LOW A	MEDIUM B	HIGH C

LIKELIHOOD OF OCCURANCE

SECTION 13
RECOMMENDATIONS

As a result of the PHA, the following recommendations were made:

Table 12.a.1

Check calibration gas expiration dates and discard any expired calibration gases. Verify that procedures are in place to check expiration dates.

Check all sensors to verify that the set points programmed by the manufacturer are labeled on the sensor.

Verify that Coordination Agreements and or Memorandums of Understanding are in place between JCI and applicable local emergency response agencies.

Table 12.a.4

Verify that while the bleach machine is running that the valves in the vent line to the bleach blow vat being circulated are open.

Table 12.a.5

Verify that the low level set point on the bleach make vat(s) is programmed to be above the bottom of the sparger tube (supply pipe).

Table 12.a.6

Verify that the low level set point on the sodium bisulfite make vat(s) is programmed to be above the bottom of the sparger tube (supply pipe).

APPENDIX A – Documentation of Actions Taken

Recommendation	Action to be Taken	Date to be Completed	Responsible Person	Date Completed / Initial	Communicated to Staff?
Check calibration gas expiration dates and discard any expired calibration gases. Verify that procedures are in place to check expiration dates.	Discard any expired calibration gases. Make sure that the expiration dates on all calibration gases are checked each month during the monthly safety and security equipment inspection.	4/1/2014	Roger Costain		
Check all sensors to verify that the set points programmed by the manufacturer are labeled on the sensor.	Mark the manufacturer's programmed set point on the sensor if needed.	4/1/2014	Roger Costain		

Verify that Coordination Agreements and or Memorandums of Understanding are in place between JCI and applicable local emergency response agencies.	Follow up with any agencies that have not returned their Coordination Agreement or Memorandum of Understanding and ask them to send it to us ASAP.	5/1/2014	Frank Levin and Cindy Lemieux		
Verify that while the bleach machine is running that the valves in the vent line to the bleach blow vat being circulated are open.	Open the applicable valves in the vent line if needed.	4/15/2014	Roger Costain		
Verify that the low level set point on the bleach make vat(s) is programmed to be above the bottom of the sparger tube (supply pipe).	Re-set the low level set point if needed.	4/15/2014	Roger Costain		

Verify that the low level set point on the sodium bisulfite make vat(s) is programmed to be above the bottom of the sparger tube (supply pipe).	Re-set the low level set point if needed.	4/15/2014	Roger Costain		